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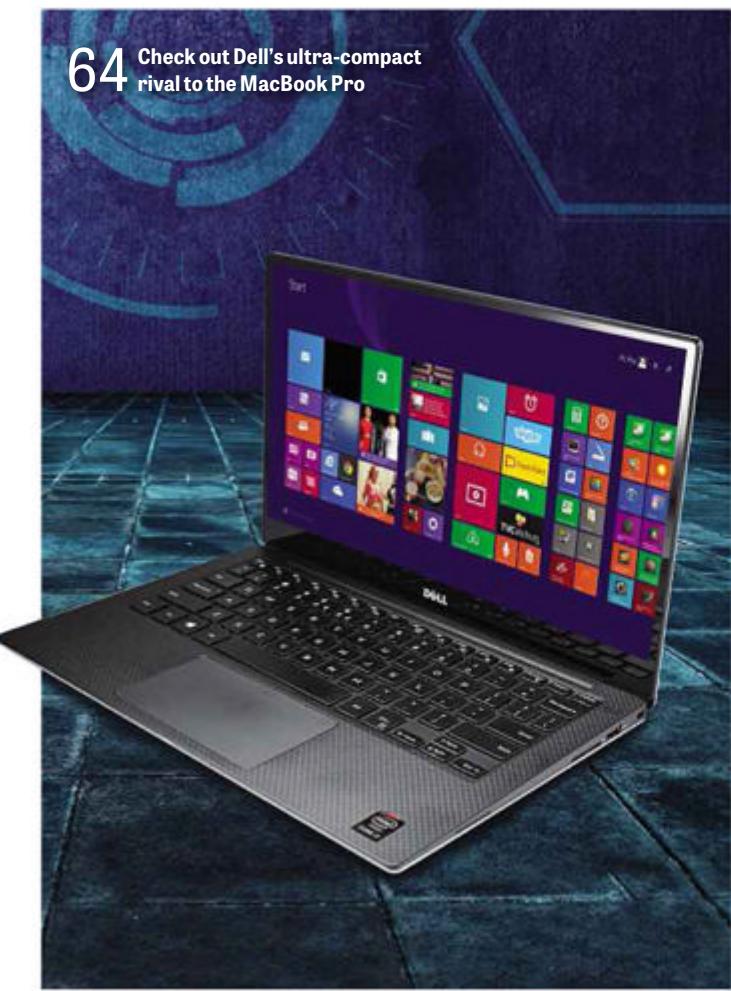
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Surfing the web is about to get faster – and more secure; plus, we reveal the five locations being considered for the UK's first spaceport.

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Here's an idea: Design the smallest, fastest, smartest LaserJets ever.

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The world's most preferred printers.



The world's most preferred printers: Worldwide printer market share, and HP printer brand awareness, consideration and preference study in nine markets 2014.

¹ Based on HP internal testing of predecessor devices completed 1/2015 or published information and subject to device settings. Actual results may vary. Faster refers to First Page Out Time (FPO). For energy efficiency, the HP M252 is 15%, the HP M277 is 16% and the HP M553 is 53% better versus predecessor. For details see hp.com/go/jclaims.

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Editor's letter

“THE LITTLE FINGER on your right hand – or the internet?” This was the question posed on Facebook earlier this week by Real World Computing columnist Paul Ockenden. I didn’t have to ponder for long: I mentally sacrificed one of my digits in a heartbeat. After all, if Homer Simpson needs only three fingers on each hand, I don’t see why I should be so greedy as to require four.

But it’s a terrifying thought. I mean, who could live without the net? While there are times I’d pay good money to give up Facebook, to delight in life without Twitter, even to forego online shopping, to wholly sacrifice the amazing internet-protocol-based organism that supports my digital life would be too much to bear.

And if it’s difficult for me, spare a thought for those who don’t remember a time when you had to check the Encyclopaedia Britannica to find out what Joseph Stalin’s middle name was (Vissarionovich, just for the record). Such digital upstarts are increasingly among us, even here at PC Pro: the youngest member of our team, Vaughn Highfield, was born in 1990. That’s the year in which Photoshop sprung into life, with consequences we explore on p54, the same year Tim Berners-Lee was beavering away on a formal framework for the world wide web.

Of course, I was happily unaware of either world-changing event at the time. For me, using a computer in 1990 was an insular experience. The programs I recall boil down to WordPerfect, XTreeGold and Prince of Persia: one for writing, one for file management (I’ve always been an interesting chap) and one for gaming. The idea of hooking up to an international network of PCs would have seemed bizarre: computers were for completing a specific task, or making one set of pixels attack another set of pixels.

When you look back through this prism at computing 25 years ago, it’s striking how the nascent technology was attempting to mimic the real world. Now it is the real world, and in some sense it’s getting smarter too: map out all the major internet “nodes”, and the connections between them, and the Earth becomes overlaid with what looks remarkably like a neural network.

In the space of a generation, internet access has become such an intrinsic part of our lives that the United Nations is calling for it to be a human right. And I can see its argument too. As an illustration, flick through the 88 apps we’ve selected for our main feature (see p42). How many of them are there to improve your life, to save you time, to make you a better, fitter person? Why should we have that advantage and others not?

Reading through the list hammered home to me just how dependent I’ve become on the internet. I’m not merely talking about those apps I find handy but could easily live without – the likes of SwiftKey and Shazam – but those that are now such a core part of my days and weeks that I’d struggle without them. For me, that’s TuneIn Radio for on-demand radio, Strava for keeping track of my running training and Pocket for capturing interesting articles to read on the train home.

Those life-enhancing tools are the real reason I’d willingly sacrifice my little finger for the internet. Which leaves just one question unanswered: what, exactly, does Paul want with all those spares?

Tim Danton
Editor-in-chief

CONTRIBUTORS



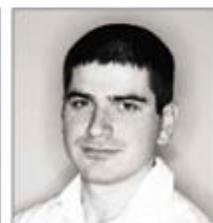
Adam Banks
As the former editor-in-chief of MacUser, Adam knows a thing or two about Photoshop. On p54, he delves into its controversies.



David Court
Want to know how to exploit Google Analytics to help grow traffic? Then David, online editor of pcpro.co.uk, has some tips to share on p32.



Iestyn Lloyd
What’s it like developing software for Oculus Rift? BAFTA winner Iestyn Lloyd reveals on p116 what it takes to create virtual-reality experiences.



Barry Collins
Former editor of PC Pro, Barry is now a director of Lewes FC. On p22 he talks to Scout7, maker of the scouting software used by Premier League clubs.

EDITORIAL
 EDITOR-IN-CHIEF
Tim Danton: editor@pcpro.co.uk
 DEPUTY EDITOR
Darien Graham-Smith
 REAL WORLD COMPUTING EDITOR
Dick Pountain: rwc@pcpro.co.uk
 BRIEFING & FUTURES EDITOR
Nicole Kobie
 REVIEWS EDITOR
Jonathan Bray: reviews@pcpro.co.uk
 DEPUTY REVIEWS EDITOR
Sasha Muller
 ONLINE EDITOR
David Court
 SENIOR STAFF WRITER
Vaughn Highfield
 STAFF WRITER
Jane McCallion

ART & PRODUCTION
 DESIGNER
Paul Duggan
 FREELANCE DESIGN
Bill Bagnall, Sarah Ratcliffe, Heather Reeves
 PRODUCTION EDITOR
Monica Horridge
 SUB-EDITORS
Vincent Forrester, Priti Patel
 CONTRIBUTING EDITORS

Tom Arah, Steve Cassidy, Jon Honeyball, Simon Jones, Dave Mitchell,
Mark Newton, Paul Ockenden, Kevin Partner, Davey Winder
 CONTRIBUTORS
Stuart Andrews, Adam Banks,
Barry Collins, Gareth Halfacree,
David Hunt, Iestyn Lloyd, Adam Shepherd,

Dave Stevenson, Mark Wood
 PHOTOGRAPHY & PRE-PRESS

Danny Bird, Henry Carter, Phil Dawson, Jenni Leskinen, Russ Nicholas

ADVERTISING TEL: 020 7907 6662
FAX: 020 7907 6600

SENIOR ADVERTISING MANAGER
Ben Topp: ben_topp@dennis.co.uk
 SALES EXECUTIVE

Trishita Shah: trishita_shah@dennis.co.uk
 STRATEGIC AD DIRECTOR (DIGITAL)

Paul Lazarra: paul_lazarra@dennis.co.uk
 STRATEGIC AD DIRECTOR (DIGITAL)
Julie Price: julie_price@dennis.co.uk
 COMMERCIAL DIRECTOR (DIGITAL)

Hannah Dickinson: hannah_dickinson@dennis.co.uk
 STRATEGIC AD MANAGER (DIGITAL)
Matthew Sullivan-Pond: 001 646 717 9555
 matthew_sullivan@dennis.co.uk

AD PRODUCTION TEL: 020 7907 6055
 GROUP PRODUCTION DIRECTOR **Robin Ryan**
 PRODUCTION MANAGER **Kerry Lambird**
 PRODUCTION CONTROLLER **Anisha Mogra**

CIRCULATION & SUBSCRIPTIONS
 Tel: 0844 844 0083 pcpro@servicehelpline.co.uk
 CIRCULATION MANAGER **Emma Read**
 NEWSTRADE DIRECTOR **David Barker**

COVER DISC TECHNICAL SUPPORT
 coverdiscs@servicehelpline.co.uk

REPRINTS TEL: 020 7907 6625
Ben Topp: ben_topp@dennis.co.uk

What app could you not live without?

"I'm no good with imperial weights and measures, so Convert Units is my Rosetta Stone for talking to my elders (and Americans)."

"Fake Name Generator – handy for Wi-Fi portals that demand registration."

"I used to be useless at buying plonk; thanks to Wotwine I now bring home bottle after bottle of the good stuff."

"Doggie Pubs – a great way to find a dog-friendly hostelry when my best friend fancies a swift pint."

"I have the memory of a fish, so I can't live without my day-planner – sad, I know!"

"The ads team has eschewed benevolence and now relies on the Tea Round app to decide whose round it is."



EDITORIAL Tel: 020 7907 6000

LETTERS letters@pcpro.co.uk

TWITTER @pcpro

FACEBOOK www.facebook.com/pcpro

SUBSCRIPTION ENQUIRIES 0844 844 0083

PC Pro, 30 Cleveland Street, London W1T 4JD

Dennis Publishing Ltd.

GROUP MANAGING DIRECTOR Ian Westwood

MANAGING DIRECTOR John Garewal

DEPUTY MANAGING DIRECTOR Tim Danton

DIRECTOR OF ADVERTISING Julian Lloyd-Evans

FINANCE DIRECTOR Brett Reynolds

GROUP FINANCE DIRECTOR Ian Leggett

CHIEF EXECUTIVE James Tye

COMPANY FOUNDER Felix Dennis

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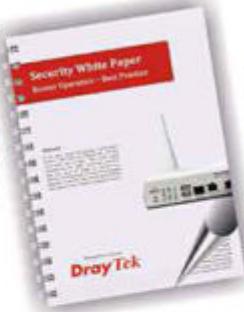
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Briefing



Background and analysis on all the important news stories

Mobile World Congress 2015

We pick our favourite products from this year's show p12

The General Election: technology

Find out where the three main parties stand on tech issues p14

PC Probe

How will Microsoft make money from its "free" OS? p16

Apple MacBook: the end of physical connectors?

Apple has surprised many by releasing a new MacBook with a single port for both charging and connecting peripherals. **Nicole Kobjie** asks whether this is a sign of things to come

FORGET THE £13,500 Watch Edition: for many, Apple's boldest revelation at its launch event this month was a laptop featuring a single USB port for both charging and attaching peripherals.

The latest version of the Apple MacBook is even thinner than current MacBook Air models, and partners a Retina display with a lightweight Core M processor, therefore needing no internal fan. It also includes a new "Force Touch" trackpad that can differentiate light taps from harder

peripherals are connected – at least, not without an external adapter. But perhaps we shouldn't be surprised: "Apple has never been risk-averse when it comes to making changes," said IHS iSuppli analyst Rhoda Alexander. "It makes total sense given what the firm was trying to do, which is to minimise the footprint of the device while maximising features. It's the direction consumers are moving in – increasingly clean design elements with fewer ports that are universal."

And while the lack of traditional USB and Thunderbolt connectors has frustrated some, this certainly isn't the first time Apple has made an early move to abandon what it sees as legacy technologies: the original iMac ditched floppy disks in 1998, and the 2008 MacBook Air shipped without an optical drive. The new MacBook is designed for a wireless future, and Apple is banking on the older ports being seen as superfluous.

"It's certainly possible, and if you look at the direction in which things are heading, it's achievable," said Alexander, noting that systems such as AirDrop,



AirPlay and Bluetooth all reduce the need for physical connections. The only irreplaceable connector is the charging port: wireless charging is still too slow, and requires a dedicated charging pad, so for now it's more convenient to carry around a regular power supply.

ABOVE The inclusion of a single port has enabled Apple to create its thinnest laptop yet

A breath of fresh Air? The new MacBook also shakes up Apple's product line. "To design a new product that's slimmer, lighter and thinner than the Air products was an

"This certainly isn't the first time Apple has made an early move to abandon what it sees as legacy technologies"

presses (as does the new MacBook Pro; see p66 for our review), and is the first Apple device to use the USB Type-C connector, which carries data, video and power via a single cable.

Controversially, Apple has included only one such port, meaning the laptop can't be charged while

Five stories not to miss

1 Tag Heuer smartwatch

Tag Heuer has created its own Android Wear device. Designed to look like its luxury Carrera watch, it incorporates smart features such as location tracking. CEO Jean-Claude Biver isn't concerned about Apple's rival, declaring it will "get young people used to wearing a watch."



2 Dyson's £15m for battery tech

Sick of your smartphone battery dying? Help is at hand from Dyson, maker of vacuum cleaners. The British firm has invested in Sakti3, which hopes its solid-state batteries will offer twice the capacity of lithium-ion units. It could lead to smaller, slimmer devices.



3 Twitter cracks down on trolls

Twitter is again trying to battle online trolls, this time by rolling out a "quality filter" that lets users opt out of seeing tweets from "suspicious" accounts, or those that contain threats or offensive language. So far, it's only available on verified accounts. The company has also promised new measures to deal with abusive tweeters.

interesting move," Alexander said. She suggested that the decision not to use the word "Air" in the device's branding gives Apple an opportunity to "reset the price point" – in other words, to increase it. The new MacBook starts at £1,049 with 256GB of storage, while the cheapest 11in MacBook Air now comes in at £749. "If you go back to the MacBook name, you raise the bar at which you can put the price point – which is appropriate with the kind of innovation that the firm has put into the device."

That doesn't mean the Air branding is dead, however. Alexander predicted that the company's next move might be a 12.9in iPad Air that can be paired with a keyboard, to offer a middle ground between the standard iPad and the MacBook line. ●

The Secret Diary of Tim Cook

We've always said, we'll take our time to create an experience that's really unique. With Apple Watch, we've been stringing out the launch for an incredible seven months now. That's something no-one in the industry has ever managed.

In that time, the other guys have come along with watches of their own. But these low-cost products come and go. We've been working hard to make Apple Watch something you won't want to replace, and our pricing strategy is a big part of that.

And lastly – this is the part that I think is really exciting – inside Apple Watch you'll find our lightest, slimmest battery ever. It's an amazing piece of innovation, and I think you're going to love charging it.

4 Yahoo ditches passwords

If you still use Yahoo email, then passwords may soon become a thing of the past. Instead of remembering a secret phrase, during login you'll be asked to enter a one-time verification code that will be sent to you via text. So far, the new system is available only in the US, but it's expected to roll out more widely soon.



5 BT mobile is back
BT is expected to launch a 4G service, piggybacking on EE's network. BT is in the middle of buying network operator EE, so it's an obvious move – one that sees BT return to the consumer mobile market after a 15-year absence.

Windows 10: what's new for the next-gen OS

Windows 10 is on its way, and Microsoft has been slowly unveiling its next operating system's features ahead of its full release later this year. Here are five intriguing revelations about the next generation of Windows that you need to know.



Goodbye IE, hello Spartan

Windows 10 will replace the much-maligned Internet Explorer 10 with a new browser, dubbed Spartan. Microsoft has built it from the ground up to be lighter-weight and cleaner than its predecessor; new features include the ability to handwrite annotations directly onto web pages. But IE isn't entirely dead – it will be made available for enterprises and anyone else who needs the legacy browser for apps.

Windows for free

Microsoft has also revealed that most Windows users will receive the new OS as a free upgrade. If you're on Windows 7 or 8.1, it will be free; if you're on Windows 8, you'll need to update to version 8.1 first. Windows 10 won't be available for devices running Windows RT – the ARM version of the OS – which includes Microsoft's Surface RT tablets. Smartphones running Windows Phone 8.1 will be updated over the air, but those running Windows Phone 7 or 8 won't.



Pirates prosper

These upgrades also apply to computers running "non-genuine" versions of Windows – in other words, devices running pirated copies. Microsoft announced at a conference in China – home to many dodgy copies of its software – that even pirated copies will be upgraded for free, in the hope that customers will see the value of "properly licensing" the software. Users of such software won't receive support from Microsoft, however, with it still being considered "non-genuine".

Peer-to-peer updates

Someone at Microsoft has clearly been hanging around The Pirate Bay; in addition to updating pirated copies of its software, the company is expected to use peer-to-peer technology to issue updates. Microsoft hasn't officially confirmed such reports, but a leaked build shows that Windows Update includes an option to allow "updates from more than one place"; in other words, users will be able to download patches and software updates more quickly by accessing further sources.

Minimum specifications

Usefully for all those considering upgrading to a new laptop now, rather than waiting for Windows 10 to arrive, Microsoft has revealed the minimum hardware requirements. The 32-bit version will need at least 1GB of RAM and 16GB of storage, while the 64-bit installation will need 2GB of RAM and 20GB of storage. Microsoft is mandating that "professional" devices must have displays of at least 7in, while consumer models must start from 8in. Windows 10 will run on mobile devices with 512MB of RAM for lower-end handsets, while smartphones with higher resolutions will require up to 4GB of RAM. All must have a minimum of 4GB of storage, with displays of between 3in and 7.9in.

The best of Mobile World Congress 2015

We trawled the halls of MWC 2015 in search of the most exciting products. Here are just some of our winners



Samsung Galaxy S6 and S6 edge

Samsung used MWC to unveil the Galaxy S6, which eschews plastic for a metal-and-glass body, alongside a more exotic "edge" version featuring a display that's curved on both sides.

The design is stunning: the rear of both phones is coloured metal covered in Gorilla Glass 4, making it shatter- and scuff-resistant, as well as giving it a shimmer when it catches the light. Each has a 5.1in Super AMOLED display with a resolution of 1,440 x 2,560.

Inside, the phones are packed with the latest tech, including an eight-core Samsung Exynos SoC with four 2.1GHz cores and four 1.5GHz cores, built using a 14nm manufacturing process. There's also 3GB of RAM, and Samsung has introduced a new type of flash storage, which combines characteristics of low eMMC and faster SSDs. The camera is an upgrade on last year's S5, too, with optical image stabilisation and a wider f/1.9 aperture.

The Samsung Galaxy S6 costs £600 for the 32GB model.

The S6 edge is only available in 64GB and 128GB sizes, costing £760 for the 64GB version. See p68 for our full review.

HTC One M9

The HTC One M8 was popular at PC Pro – it even converted one former editor away from his iPhone – and its successor doesn't stray far from that design. The M9 has a full metal body and a 5in screen, but it's a slightly more angular design, making it easier to grip. The camera has been boosted from the M8's 4-megapixel unit to 20 megapixels. Inside, it runs HTC Sense 7 on an octa-core Snapdragon 810, has Adreno 430 graphics, 3GB of RAM, and 32GB of storage, plus a microSD slot. The HTC One M9 costs £580 SIM-free. See our review on p69.



HTC Vive

It may look similar to the Samsung Gear VR, but HTC's take on virtual reality works differently. With the Vive, you don't slip a mobile device into the front to use as a display and for processing power; instead, it has its own built-in display and you hook it up to your PC to play. The downside of this is that you need to be connected via cable, but the upside is that it's able to offer higher-resolution gaming. Developed in partnership with Valve, HTC claims the Vive will arrive by the end of the year.



Pebble Time Steel

Just a week after Pebble announced its new Pebble Time smartwatch, it chose MWC to unleash its premium sibling. The Pebble Time Steel has a luxurious metal body, a colour screen, a mic to record voice memos, and an expansion connector, enabling extra features such as batteries and heart-rate monitors to be added via "smartstraps" in the future. What's more, battery life is claimed to be up to ten days. Forget the Apple Watch – the Pebble Time Steel is the smartwatch to beat this year, and it's only \$250 (around £169).



Huawei Watch

The Huawei Watch has the highest pixel density of any wristborne wearable yet, with its 400 x 400 resolution giving 286ppi. It features an AMOLED panel, displaying inky blacks, perfect viewing angles and crisp onscreen images. All this is topped with sapphire glass for protection. Internally, its specification is fairly standard – a Snapdragon 400 chip, 512MB of RAM and 4GB of storage to run Android Wear – but the battery is smaller than that of its rivals.

PC Pro's Top Picks

Best phones

Samsung Galaxy S6 edge
Samsung Galaxy S6
HTC One M9
Microsoft Lumia 640 XL

Best phablet

Huawei MediaPad X2

Best tablet

Sony Xperia Z4 Tablet

Best wearables

Pebble Time Steel
Huawei Watch
LG Watch Urbane

Best innovation

HTC Vive

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Ben Wallace, Director of drpdigital at drp
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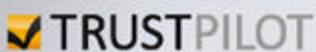
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Election Special

Does technology matter in the General Election?

Many of the issues facing the United Kingdom are underpinned by technology.

Nicole Kobjie reveals where the main three parties stand on key questions

BROADBAND, SURVEILLANCE and online censorship are all important issues to the tech community – but they’re unlikely to be the factors that any of us votes for in the General Election in May.

Instead, it will be the economy, immigration and the NHS that dominate, according to ComRes pollster Katharine Peacock, speaking at a meeting of the Parliamentary Internet, Communications and Technology Forum (PICTFOR). Yet this doesn’t mean technology is an irrelevance. As Peacock explained: “These three are important for technology... It underpins a wide range of issues.”

Antony Walker, deputy CEO of industry body techUK, agrees. “Politicians will find it hard to connect on the doorstep on tech issues, and yet technology underpins the solution to every single issue that this electorate cares about: the economy, public services and, in particular, the NHS,” he said.

Look at immigration: to actually know who is in the country or who isn’t would defuse much of the negativity around the discourse, and it’s “eminently solvable from a tech point of view”, said Walker. PICTFOR speakers also noted how many public sector bodies and councils turn to technology to help cut budgets in the face of austerity measures. “Thank goodness we have the tech community saying it’s possible to do more – and better – with less, through smarter use of technology and data,” said Eddie Copeland, head of tech policy at Policy Exchange.

So while Britons will decide the next government on other issues, it will be technology that makes them a success. And this makes it all the more problematic that few politicians are actually technically minded. Copeland warned that policy needs



to be led by politicians – not the IT department. “It’s a derogation of political responsibility for the public sector reform agenda to be relegated to the IT department,” he said. “We shouldn’t have the tail of the IT department wagging the tail of public sector reform – it doesn’t work that way.”

The speakers at the PICTFOR meeting noted that little distinguishes the three major parties on technology issues – Walker said their policies are like a Venn diagram with a lot of overlap. Here, we reveal a few key differences and how the parties have approached tech policies in the past few years.

Conservatives

It's easy to judge the Tories on tech: we've had the past five years to watch the party's successes and missteps,

ABOVE Whichever party gains power in May, tech will be at the forefront of solving the issues that are of most importance to the public

and in the most recent budget it announced further investment into technology.

David Cameron's government has invested attention as well as funding into east London's Tech City, kick-started driverless car pilots, and funded testbeds for robots and the Internet of Things. In addition, the party has pushed programming into the education curriculum and paved the way to build the UK's first spaceport. The Tories are keen for Britain to become a leader in all things digital and tech, seeing it as a way to ensure our economy continues to grow.

On the flip side, the Broadband Delivery UK project – which the Tories inherited from Labour – has seen all

“ Many public sector bodies turn to technology to help cut budgets in the face of austerity ”

the promised funds handed to BT, while the project has been pushed back by another two years. The Tories clearly see the value of broadband, pledging in March's Budget to roll out 100Mbps/sec connections across the country, but didn't set a deadline or provide other key details. ISPs have already started such work with their fibre rollouts, so it's unclear what the government will add.

The government has been more hands-on in other areas – notably the effort by Cameron and Claire Perry MP to push ISPs to implement network-level parental control filters, despite the tech industry warning against such plans. A failure to heed expert opinion also saw the NHS Care.data plans held back after widespread criticism, and the controversial Digital Economy Act – another inheritance from the previous Labour government – has all but fallen by the wayside.

Finally we come to surveillance. The government's defensive reaction to the Snowden revelations disappointed observers, while experts warned that its continued push to collect more communications data in response to every terror incident is as impractical as it is headline-friendly. The prime minister even suggested online communication should be readable by authorities, with many interpreting that as a vote against encryption.

Liberal Democrats

Many of these developments mentioned above took place in a coalition with the Liberal Democrats, but there were a few



ABOVE To a large extent, there's a consensus from all three parties on tech issues

sparks between the two parties. Nick Clegg's party repeatedly stood up against the Communications Data Bill, refusing to let the so-called Snoopers' Charter pass. They did eventually let through emergency surveillance legislation, but Lib Dem Julian Huppert MP – one of the more tech-savvy politicians in the Commons – has said this was only allowed thanks to the introduction of a sunset clause, meaning it will have to be renegotiated soon.

The Lib Dems have also called for a Digital Bill of Rights, to protect privacy and data rights online. "The Digital Bill of Rights we're proposing will protect our fundamental liberties online. They mean that British residents will be protected from unwarranted state surveillance, while still maintaining the ability for our security services to deal with serious threats," Huppert said at the time the proposal was announced. "Protecting people's privacy is an essential part of building the society we want to live in, and

when people violate that, there have to be proportionate powers available to hold those responsible to account."



Labour

Labour has pledged to create more technical degrees and modernise the NHS, and started the broadband-improvement plan back when it was in power. In particular, one MP has done much to push the broadband agenda: Chi Onwurah has frequently called out the government and BT for perceived failures in the rollout. She also leads a review of digital services in government, and has warned against the government's attitude of "get online or lose out".

"The Government Digital Service (GDS) is a hugely experienced and talented group within government," she said, "but ministers have focused on headline-grabbing services that can only be used by 80% of the population, rather than building more valuable services that can be used by everyone and that help with some of this country's biggest challenges such as economic growth, planning, housing or health and social care."

In the last administration, Labour was responsible for introducing the Digital Economy Bill and has also pushed for ID cards. Alongside the Lib Dems, Labour too has backed the emergency surveillance bill. The party has called for more attention to be paid to surveillance, but like the Tories has stressed that police and security services need access to data. If it's an overhaul of the surveillance state you want, the only party calling for it is the Greens. ●

Online voting

Every election, one issue always comes up: is it time to switch to online voting?

Katherine Peacock from ComRes told attendees at the PICTFOR meeting that young people in particular want the ability to vote online. "I do my banking online, which is the most sensitive thing I could do, so why can't I vote?" she asked. A poll conducted by her firm found that 63% of people surveyed said they'd vote online if they could – a figure that's well above actual turnout rates. On the flip side, most MPs when polled said they didn't think it would widen participation and don't think it can be trusted.

A recent report from WebRoots Democracy echoed Peacock's stance, pointing to the success that Estonia has had in previous elections. Others disagree. The Open Rights Group (ORG) said that security issues around e-voting haven't been addressed, calling enthusiasm for it "misguided". "Given the number of things we do online, it may seem that internet voting is a



good idea – but as yet no-one has developed software that can guarantee that voting will be secret, secure and accountable," said ORG's executive director, Jim Killock.

"For internet voting to be secure, we'd need to ensure that every voter's device hadn't been tampered with. Online voting

gives much greater opportunities for electoral fraud; these concerns are shared by many computer scientists and academics but aren't sufficiently addressed in this [WebRoots] report."

Killock pointed to Estonia, noting that independent observers found security flaws in its online voting systems, including the ease with which a botnet could be used to overwrite votes. "Voting is a uniquely difficult challenge for computer science: the system must verify your eligibility to vote; know whether you have already voted; and allow for audits and recounts," he added. "Yet it must always preserve your anonymity and privacy. Currently, there are no practical solutions to this highly complex problem, and existing systems are unacceptably flawed."



PC Probe

How Microsoft will make cash from its “free” OS

If Microsoft won't be charging for upgrades to Windows 10, and it's being bundled free with tablets, how will it keep the cash rolling in? **Barry Collins** investigates



It's free on phones, on compact tablets, and now for those who already have Windows 7 or 8 installed on their PCs. Is Windows, as Microsoft's chief operating officer was asked recently at the Credit Suisse Technology Conference, becoming a “loss leader”? Will it be given away for peanuts to lure people towards more lucrative products, such as Office 365?

Kevin Turner's answer was “no”, but the fact that Microsoft is even being asked whether the Windows cash cow has been flogged to death is indicative of the predicament in which the company finds itself. It's still the only operating system most people would even consider running on home or business PCs, but it's also the last operating system most people want on their phones and tablets.

Can Microsoft still get away with charging consumers and businesses for an operating system? Will it become a subscription product, along the lines of Office 365?

And are we witnessing the last of the major Windows releases? We've canvassed the opinion of the experts to find out.

No free lunch

Let's be clear: despite the headlines proclaiming otherwise, Microsoft is not giving Windows 10 away for “free”. Although the company has announced it will be a free upgrade for the vast majority of PC users, it only ever collected a tiny proportion of its revenue from those paying to upgrade Windows on their PCs. “Are they giving away billions of dollars?” asked Al Gillen, a vice president at analyst firm IDC. “No. I don't even think they're giving away hundreds of millions of dollars.”

The vast majority of Microsoft's Windows revenue comes from charging PC manufacturers to preinstall the OS on new PCs, and from volume licensing to businesses – and those enormous revenue streams aren't about to disappear overnight. Even with Microsoft waiving Windows licence fees for compact tablets, it isn't really costing the company money. “Microsoft had no revenue in that marketplace in the first place, so it isn't giving anything up,” Gillen pointed out.

Gillen compares Microsoft's predicament on phones and tablets to that of its problem with piracy. The company makes virtually no revenue from Windows in countries such as China, where piracy rates are sky high, and could probably “shut piracy down tomorrow if it wanted to.” But it would rather have people participating in the Windows ecosystem, even if they aren't paying for it, than have them using an alternative OS.

Yet, with Windows 10 now spanning everything from phones to workstation PCs, will the likes of Dell and HP resent paying Microsoft huge licence fees to preinstall Windows on PCs and laptops while others are getting a free copy of the same OS for their compact tablets? The real question might be: what choice do they have? “Microsoft will continue to charge on the PC because it can,” said Gillen. “Yes, Linux is viable and free, but nobody really uses Linux [on the desktop].”

■ Windows 365?

Microsoft hasn't completely given up on earning revenue from phones and compact tablets, even if it isn't charging a traditional licence fee. "We have to monetise it differently," said Microsoft COO Kevin Turner when asked at that Credit Suisse conference if the company was prepared to lose money on Windows. "There are additional opportunities for us to bring additional services to the product and do it in a creative way... finding new ways to monetise the lifetime of that customer on those devices."

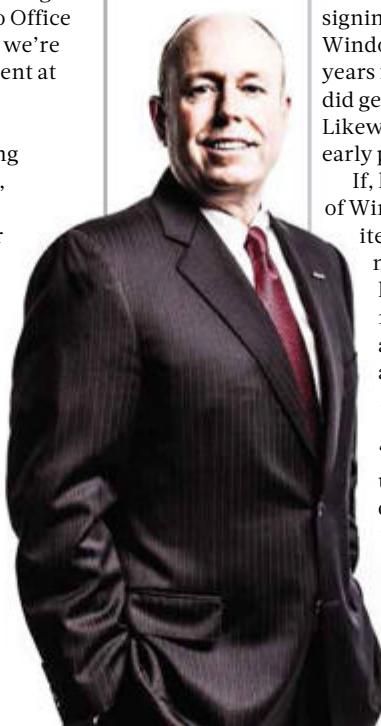
Many commentators interpreted that final comment as a signal that Microsoft intended to turn Windows into a subscription product, in the same way that it's managed to convert more than nine million Office users into Office 365 subscribers. "I really don't believe that's what we're going to see," said Wes Miller, research vice president at Microsoft analyst firm Directions on Microsoft.

Instead, Microsoft will attempt to sell other products and services to those users who are getting Windows for free: Office 365, Skype subscriptions, Xbox Live, and services that might not even exist yet. "Services are going to be absolutely critical for Microsoft going forward," said Nicholas McQuire, vice president of enterprise at analyst CCS Insight. "The Office experience is obviously the jewel in the crown for Microsoft, [but] it's up to Microsoft to find new services."

■ Faster releases

One thing's for sure: Microsoft is going to need to step up the rate of new Windows releases if it's to keep both consumers and businesses hooked. The company has talked of accelerating product release cycles for the past couple of years, not least because it hooks subscribers on the promise of getting access to the latest

BELOW Chief operating officer, Kevin Turner, sees Microsoft making money through its services



"Microsoft is going to have to step up the rate of new Windows releases if it's to keep customers hooked"

features as soon as they're released. Yet, Office 365 subscribers have seen no major changes to the desktop software since Office 2013, and those businesses on Software Assurance deals – which give volume-licensing customers the right to upgrade to the latest major versions of Microsoft products

as they're released – have rarely seen much benefit.

Miller said the hit/miss cycle of Windows releases over the past couple of decades means businesses have often received a raw deal from Software Assurance. A company signing a Software Assurance deal at the beginning of the Windows XP life cycle would have had to have waited six years for the next major OS release, "and even when I did get something, it was Windows Vista," said Miller. Likewise, many of those who moved to Windows 7 in the early part of this decade have ignored Windows 8.

If, however, Windows 10 becomes the last major release of Windows – with Microsoft releasing lots of small,

iterative updates to the current OS instead of major new versions – Software Assurance becomes even less attractive. "We're not going to see Windows 11, 12 or 13," said Gillen. "We'll see Windows 10 remain as the basic brand [for years to come]." Miller agreed, arguing: "Why would a business go and get Software Assurance now?"

McQuire added that Microsoft faces a "monumental" challenge in keeping Windows 10 updated at roughly the same rate across all of its device categories: that is phone, tablet and PC, not to mention the emerging Internet of Things market. "The underlying experience of a single operating system across different form factors is an important point of differentiation for Microsoft," he said.

Microsoft has thrown an enormous number of balls into the air. We're about to find out if the company can juggle. ●

Adopting the Ubuntu approach

Windows 10 has already "borrowed" one big idea from the Linux world: the virtual desktops that are now part and parcel of the operating system. Now it's set to appropriate another, to help businesses adapt to the new rapid release schedule it's promising.

If, as expected, Microsoft ditches the idea of major Windows releases and instead delivers continual, incremental updates to the operating system, IT managers are presented with a fresh headache. How do they test and validate updates that could be released every few weeks? It could even put businesses off upgrading to Windows 10, which would be a

disaster for Microsoft after Windows 8 was widely shunned in the business world.

Wes Miller from Directions on Microsoft predicted that the company would adopt the same approach as Ubuntu, issuing regular releases on a continual basis, and then delivering a stable, staging-post update every year or two, similar to the biennial Long Term Support (LTS) releases that Canonical produces for businesses. "I think that [Long Term Support releases] is exactly what we're going to see [with Windows 10]," said Miller. "Even the names they've suggested for it are almost exactly the same as they are for Ubuntu Linux."



However, Miller said businesses are becoming more accustomed to dealing with incremental updates to their software and services. "Google Apps became very iterative and people are starting to get used to that," he said. "The hardware doesn't change, but the software is constantly changing."



The A-List

The ultimate guide to the very best products on the market today

Laptops

Apple MacBook Pro 13in with Retina display

(2015), from £999

apple.com/uk **NEW ENTRY**

With its innovative Force Touch trackpad, new Broadwell processors and the same excellent Retina screen, the MacBook Pro is better than ever. It's fast, with superior battery life to the previous generation, and that trackpad adds to all-round usability.

REVIEW: pcpro.link/almb13rd



ALTERNATIVES

Lenovo IdeaPad Yoga 2

A versatile hybrid laptop with the best IPS screen in its price range – now available at an irresistible price. £350; johnlewis.com **REVIEW:** pcpro.link/alyoga2

Asus Zenbook UX303LA

Sporting the latest Broadwell Core i7 and a quality screen, this Ultrabook is both desirable and great value. £700; scan.co.uk **REVIEW:** pcpro.link/alzb303

HP Stream 11

NEW ENTRY

Good looking, well built and equipped with a decent screen, the petite Stream 11 is as good as it gets for the money. £180; hp.co.uk **REVIEW:** pcpro.link/aihp11

Tablets

Apple iPad Air 2

9.7in tablet, 64GB, £479

apple.com/uk

Even faster, even lighter and just as pretty as ever – the iPad Air 2 takes everything that made the original great and improves on it. Updated cameras and the arrival of Touch ID are welcome upgrades, too. Its only real rival is the original 32GB iPad Air, now discounted to a tempting £359.

REVIEW: pcpro.link/alipair



ALTERNATIVES

Tesco Hudl 2

Tesco's budget Android tablet sports a high-quality 8.4in IPS display. You can't top that for value. £129; tesco.com **REVIEW:** pcpro.link/ahudl2

Linx 8

Part of a new wave of ultra-affordable compact Windows tablets, the Linx 8 squeezes plenty in for the price. £90; pcworld.co.uk **REVIEW:** pcpro.link/allinx8

Sony Xperia Z2 Tablet

The most desirable full-sized Android tablet yet, thanks to great design and battery life. 16GB, £350; pcworld.co.uk **REVIEW:** pcpro.link/alxz2tab

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Smartphones

Samsung Galaxy S6

Android, 64GB, free phone,

£35/mth, 24mths **NEW ENTRY**

omio.com

With the Galaxy S6, Samsung has finally created a phone with a design worthy of its potential. Superb performance, a nigh-on perfect display and an astonishingly good camera provide the perfect foil to the most attractive Samsung handset yet.

REVIEW: pcpro.link/algals6



ALTERNATIVES

Motorola Moto G (2nd Gen)

NEW ENTRY

A bargain: 5in screen, good battery life and 4G too. Free phone, £15/mth, 24mths; omio.com **REVIEW:** pcpro.link/almotog2

Sony Xperia Z3 Compact

Speedy performance, decent battery life and a fine camera – all for a great price. Free phone, £22/mth, 24mths; omio.com **REVIEW:** pcpro.link/alsonyz3

Apple iPhone 6

Apple steps up to a larger screen size with the classy, long-lasting 4.7in iPhone – but it's pricey. Free phone, £31/mth, 24mths; omio.com **REVIEW:** pcpro.link/alip6

PCs

Chillblast Fusion Quasar

Base unit, £600

chillblast.com

Chillblast's Fusion Quasar is the very definition of a classy all-round base unit. A Core i5 CPU overclocked to 4.3GHz delivers plenty of raw power, combined with good gaming capability and serious upgrade potential. A five-year warranty seals the deal.

REVIEW: pcpro.link/alchill



ALTERNATIVES

Apple iMac 21.5in

A classy all-in-one with a compact frame, ample power and a colour-accurate screen. From £899; apple.com/uk **REVIEW:** pcpro.link/alimac215

Apple iMac 27in with Retina 5K display

Astonishing image quality and stunning resolution go hand in hand. £1,999; apple.com/uk **REVIEW:** pcpro.link/alimac275k

Armari Magnetar M18H-AW1200

A superb workstation packed with pro-level components. £6,594; armari.co.uk **REVIEW:** pcpro.link/alarmari

MONITORS

Asus PB287Q

Premium monitor, £430

[overclockers.co.uk](#)

Not so long ago, a 4K display for less than £500 was unimaginable. Asus delivers exactly that: a razor-sharp image on a 28in panel at a very reasonable price.

REVIEW: [pcpro.link/alpb287q](#)



Eizo ColorEdge CS240

Eizo ticks almost every box with the 24.1in, 1,920 x 1,200 ColorEdge CS240. With a highly colour-accurate IPS screen, it's the first truly professional-class monitor we've seen at anywhere near this price. £553; [nativedigital.com](#)

REVIEW: [pcpro.link/alcs240](#)

AOC q2770Pqu

A feature-packed, 27in 2,560 x 1,440 display offering a huge workspace, an adjustable stand, a four-port USB hub – and a three-year warranty. Super PLS technology gives great viewing angles too. At this price, it's a steal. £360; [ebuyer.com](#)

REVIEW: [pcpro.link/alq2770](#)

PRINTERS

Canon Pixma MG6450

All-in-one inkjet printer, £80

[currys.co.uk](#)

The MG6450 inherits its predecessor's status as *PC Pro*'s favourite inkjet all-in-one, offering high-quality output at a very reasonable price.

REVIEW: [pcpro.link/almg6450](#)



Canon Pixma Pro-100

Canon's professional-level inkjet printer is just the thing if you want prints that are a cut above the average. Produces sumptuous photographs at up to A3+ size, and its black-and-white output is stunning. £299; [parkcameras.com](#)

REVIEW: [pcpro.link/alpixmapro](#)

Epson Expression Photo XP-950

Epson's high-end inkjet all-in-one is a fantastic all-rounder for the enthusiast photographer. It combines high-quality prints with a decent scanner, a great touch interface and the ability to output photos at up to A3 in size. £250; [pcworld.co.uk](#)

REVIEW: [pcpro.link/alxp950](#)

ROUTERS

Netgear R7500 Nighthawk X4

AC2350 router, £170

[broadbandbuyer.co.uk](#)

Top Wi-Fi performance close-up and at long range, swift USB NAS performance, and all the latest Wi-Fi goodies make the new Nighthawk router our Wi-Fi router of choice.

REVIEW: [pcpro.link/alr7500](#)



D-Link DIR-868L

This 802.11ac wireless router may not have the most impressive set of features, and it lacks an internal modem. In our tests, however, it outpaced routers costing twice as much, making it an affordable way to get speedy wireless performance. £88; [broadbandbuyer.co.uk](#)

REVIEW: [pcpro.link/adir868l](#)

Asus RT-AC68U

Hardly a value option, but Asus' flagship router offers 3x3 wireless, four wired Gigabit Ethernet ports and a pair of integrated USB sockets for high-speed file sharing. Cloud-based access and synchronisation tools are a bonus. £176; [broadbandbuyer.co.uk](#)

REVIEW: [pcpro.link/alac68u](#)

HOME NETWORKING

Synology DiskStation DS214play

Network attached storage, £292

[ebuyer.com](#)

A hugely versatile NAS with built-in Wi-Fi and some of the best media-streaming and cloud features we've seen, as well as eSATA and USB extensibility. It packs a lot of power into a solid, compact unit.

REVIEW: [pcpro.link/alds214play](#)



Netgear ReadyNAS 314

This NAS drive isn't cheap, but it's fast, reliable and easy to use – while offering advanced features such as unlimited block-level snapshots and iSCSI thin provisioning. The best buy is the diskless model.

£502; [ebuyer.com](#)

REVIEW: [pcpro.link/alrnas314](#)

Google Chromecast

This is the future of TV streaming – cheap to buy and simple to use. Plug the Chromecast into a spare HDMI port at the back of your TV, then browse on your smartphone or tablet and beam Full HD content directly onto the big screen.

£30; [play.google.com](#)

REVIEW: [pcpro.link/alccast](#)

WEARABLES

Pebble Steel

Smartwatch, £150

[argos.co.uk](#)

The Pebble Steel isn't the flashiest smartwatch out there, but it offers great battery life, brilliant apps and a simple interface with solid physical controls. Plus, it supports both iOS and Android.

REVIEW: [pcpro.link/alpebsteel](#)



LG G Watch R

Android Wear smartwatches don't tend to have great battery life, but the G Watch R is the best we've seen. With an attractive, round-faced design, a punchy and colourful display and a heart-rate monitor, it's the best Android smartwatch so far. £192; [amazon.co.uk](#)

REVIEW: [pcpro.link/algwatchr](#)

Sony SmartBand Talk

Sony's SmartBand does more than most fitness trackers: it displays notifications, allows you to answer phone calls, and its E Ink screen contributes to above-average battery life. £108; [dabs.com](#)

REVIEW: [pcpro.link/alsonySmart](#)

SECURITY SOFTWARE

Kaspersky Internet Security 2015

Another year, another

excellent performance.

It's super-secure,

lightweight and unintrusive.

3 PCs/1yr, £25; store.pcpro.co.uk

REVIEW: pcpro.link/alkasis15

Avast Free Antivirus

Still the best free antivirus, although others are catching up. It offers dependable protection – and it doesn't nag you about upgrading. **Free;** avast.com

REVIEW: pcpro.link/alavast15



Norton Security 2015

It isn't the cheapest, but the protection provided is good and it covers up to five devices, from laptops to tablets and smartphones.

5 devices/1yr, £29; amazon.co.uk

REVIEW: pcpro.link/alnort15

PRODUCTIVITY SOFTWARE

Microsoft Office 2013

Microsoft retains the top spot for the ultimate office suite, although tablet users may be disappointed by lacklustre touch support.

From £110; office.microsoft.com

REVIEW: pcpro.link/alooffice13



LibreOffice 4

The UI looks a little dated, and Microsoft Office has the edge on features. All the same, LibreOffice is an impressively powerful office suite – and it won't cost you a penny.

Free; libreoffice.org

REVIEW: pcpro.link/allibreoffice

Scrivener

A brilliant package for serious writers: not just a word processor, but a tool that helps you organise your ideas and manage the process of composition from start to finish. **£29;** literatureandlatte.com

REVIEW: pcpro.link/alscrivener

CREATIVITY SOFTWARE

Adobe Creative Cloud

The licensing model won't suit everyone, but Adobe's suite of creative tools is second to none, covering everything from photo and video editing to web development.



Complete plan, £46/mth; adobe.com

REVIEW: pcpro.link/alccloud14

Adobe Photoshop Elements 13

Adobe's home image-editing tool is a terrific and powerful buy, although users of older versions won't find much reason to upgrade.

£53; amazon.co.uk

REVIEW: pcpro.link/alelements13

Steinberg Cubase Pro 8

A big bump in performance and a handful of UI improvements keep Cubase at the top of the audio-production tree. A worthwhile upgrade.

£404; dv247.com

REVIEW: pcpro.link/alcubasepro8

SERVERS

HP ProLiant DL80 Gen9

Massive storage capacity combines with a high-speed Xeon E5-2600 v3 CPU and a scalable design to push this HP rack server to the top of the tree. The price is very reasonable as well. **£989 exc VAT;** hp.co.uk

REVIEW: pcpro.link/alhpd180



HP ProLiant MicroServer Gen8

A space-saving microserver with excellent remote-management features that's perfect for even the smallest of businesses – and it's reasonably priced, too. **£150 exc VAT;** ebuyer.com

REVIEW: pcpro.link/alhpgen8

STORAGE APPLIANCES

Qnap TS-EC880 Pro

Qnap's eight-bay desktop NAS sets new standards in the desktop NAS appliance space, combining ultra-powerful hardware with every storage feature you could wish for. It has huge expansion potential, and 10GbE networking seals the deal. **Diskless, £1,184 exc VAT;** ballicom.co.uk

REVIEW: pcpro.link/alec880pro



Synology RackStation RS2414RP+

Built with speed and expansion in mind, this 2U rack NAS offers a veritable feast of storage features and plenty of expansion potential. It's good value, too.

Diskless, £1,352 exc VAT; ballicom.co.uk

REVIEW: pcpro.link/alsrs2414rp

SECURITY

WatchGuard Firebox T10-W

Packed with wired and wireless security features, the T10-W includes IPS, web-content filtering, application controls and HTTPS inspection. The box acts as a dual-band wireless AP, too. **From £485 exc VAT;** watchguard.com

REVIEW: pcpro.link/alfireboxt10w



Sophos Cloud

User-based policies and slick mobile support make this a top-class cloud solution. Performance is impressive, too. It's not the cheapest option, but it's a pleasure to use. **10 users, £510/yr exc VAT;** sophos.com

REVIEW: pcpro.link/alscloud

BUSINESS PRINTERS

Epson WorkForce Pro WF-5620DWF

Shatters the myth that inkjets are only for low-demand use, delivering fast output speeds, low running costs and tons of features.

It prints at 20 pages per minute, and quality is perfectly acceptable – it can even print glossy photos. **£182 exc VAT;** printerland.co.uk

REVIEW: pcpro.link/alwf5620



BACKUP

Barracuda Backup Server 290

A beautifully simple appliance that brings together on-site and cloud backup. There's block-level deduplication, extensive support for Windows systems and applications, integral Exchange MLB and simple deployment and management. **£4,446 exc VAT;** barracuda.com

REVIEW: pcpro.link/alserver290



IDrive Online Backup for Business

NEW ENTRY

Brilliant cloud backup at an unbeatable price. There are all the features you'd expect, and more besides, and it's refreshingly easy to use. **250GB, £65/year exc VAT;** idrive.com

REVIEW: pcpro.link/p102

NETWORK MANAGEMENT

Paessler PRTG Network Monitor 15

NEW ENTRY

A network-management solution that's ideal for businesses on a tight budget. Supports a wide range of devices, which are included in the price, and licensing is based purely on sensor count, so there are no hidden costs. An excellent way to keep tabs on what's going on in your network.

500 sensors, 1yr, £885 exc VAT; paessler.com

REVIEW: pcpro.link/alprt15



SolarWinds Orion NPM 11.5

NEW ENTRY

Offers excellent value for money, packing in a huge number of monitoring features as standard, including support for 802.11 wireless APs and virtual machines. **250 elements, £3,880 exc VAT;** solarwinds.com

REVIEW: pcpro.link/npm115



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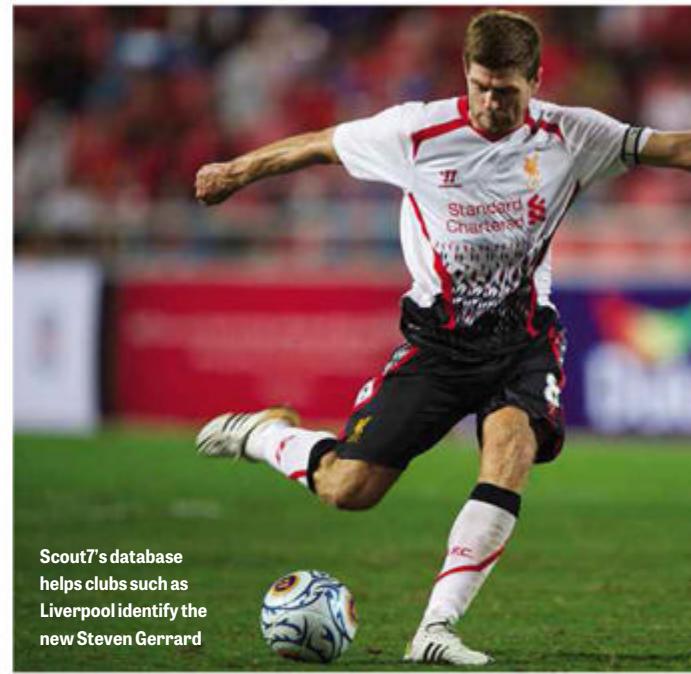


Profile

BACKGROUND INFO ON INNOVATIVE BRITISH COMPANIES

Scout7

Discovering the next Steven Gerrard used to be down to a mix of good contacts, gut instinct and pot luck. Now, a British firm is using Big Data to identify the football stars of the future



Scout7's database helps clubs such as Liverpool identify the new Steven Gerrard

KEY FACTS

SCOUT7 IN A NUTSHELL

Scout7 helps some of Europe's biggest football clubs recruit players by providing a huge database of footballers from across the world, as well as allowing clubs to manage data generated by their own scouting departments.

LOCATION

Birmingham

FOUNDED 2001

EMPLOYEES 24

WEBSITE

info.scout7.com

According to TV pundits, there are many factors that go into winning a football match: flair, guts, tactics, set-pieces, luck. There's another one that probably isn't on Robbie Savage's list of clichés, but most definitely should be: data.

In today's football industry, decisions about which player to spend £35 million on aren't based purely on the manager's gut reaction or the notes jotted down in the chief scout's little black book – they're made after months of detailed analysis tracking thousands of players from across the world. Birmingham-based Scout7 has one of the biggest scouting databases in the business, allowing top clubs such as Chelsea, Tottenham Hotspur and Liverpool to marry their own, highly confidential scouting data with the video analysis and data captured by the company.

Combining all this information and serving it up to clubs around the world, 24/7, requires powerful, custom-built data centres, tight data security and impeccable UI design. We caught up with Scout7's operations director, Bradford Griffiths, to find out how they manage it.

Scouting with SaaS

Scout7 was one of the pioneers of using computer software to identify transfer targets, something that was largely confined to players of football sim Championship Manager when the company was founded in 2001. It was also one of the earliest proponents of cloud computing.

Scout7 has a two-tier approach to scouting: it provides its own database of player data and also allows partner

clubs to create a scouting database of their own. In the first instance, clubs can search the company's database of 135,000 players worldwide to create a list of potential targets. This details the player's full history: appearances, goals, positions, injury history, transfer fees and more. Clubs often have specific requirements – they might, for instance, want a right-back, no older than 26, with an EU passport, who's played at least 75% of the games for his club over the past three seasons – and Scout7 allows clubs to filter against such detailed criteria.

When the company first started offering this database to clubs in 2001 it took a gamble, because not only was it asking clubs to adopt entirely new methods of scouting, it was asking them to access this data over the internet.

"This was a time when the internet was a fledgling as a business tool," says Griffiths, "but the decision was made to start collecting global football data and presenting it through an online application. It was ambitious to go for Software as a Service back in 2001, because these scouts weren't even working at the stadium. They were working the training ground, and training grounds weren't connected to the internet. By luck or judgement, it was absolutely the right decision."

Since 2009, Scout7 has offered curated video clips alongside the player data. Now, once clubs have a shortlist of players matching their criteria, they can watch the player's recent matches to help them make an initial assessment of whether he's the type of player they're after. Previously, clubs would have spent tens of thousands

of pounds flying scouts around the world to watch a player in action: now they can do it from the PC in the chief scout's office.

Having used the video to whittle down the shortlist, the clubs can then send their scouts to do what they've always done: visit grounds and make a first-hand assessment of a player. The top clubs employ dozens of scouts, and potential transfer targets will be watched several times by multiple experts before the manager is asked to watch the player himself. The reports from the club's own scouts are fed into the Scout7 database, so the chief scout



RIGHT The firm uses custom hardware to serve its 800TB video archive



TOP Details of every match in Europe's top leagues are stored in the Scout7 database

BOTTOM Clubs can add their own scouting data to the player records collated by Scout7



can collate and add it to the information that Scout7 provides to all of its member clubs from its own database.

This poses two challenges for Scout7. First, it has to make the scout's report forms as simple and accessible as possible, because even today your average football scout is more comfortable with a pen and notepad than a laptop.

"We're not talking about guys from technical IT backgrounds; we're talking about guys who might struggle to find things in an internet browser," says Griffiths.

Second, it has to ensure the tightest possible security, both internally and externally, because at the highest levels of football you're dealing with intellectual

property worth tens of millions of pounds. Each club's data is encrypted, and only authorised personnel within the club can access the key scouting information. This is achieved through tight management of access controls by Scout7 itself, because "clubs either didn't trust themselves to do it properly or didn't want the burden of it".

Consequently, individual scouts entering data into the system aren't granted access to the shortlists of the club's main transfer targets, because these (often poorly paid) freelancers could pass that hugely valuable information on to other clubs. What's more, if the chief scout receives a better offer to join a rival club, he can't take all that valuable information with him, because it's all stored on Scout7's servers – something that makes Scout7's cloud-based service even more attractive to the CEOs of the leading football clubs.

“The tightest possible security is essential, because we’re dealing with intellectual property worth millions”

Powering the scouting

Scout7's scouting database isn't only used to identify new players, it's also a source of intelligence on rivals. The video database can be searched to, say, review the past ten goals scored by a forthcoming opponent, or watch a team's set-piece routines. These curated video clips can be shared with players in team meetings or downloaded onto their iPads, so they can do their homework on the guy they'll be marking on Wednesday night.

Delivering all this data and HD video footage on demand, to clubs that pay hundreds of thousands of pounds per year for access, is no small feat of IT management. Scout7 runs a mixed environment, using some third-party cloud services and some of its own high-performance Intel Xeon-based servers. "The bare-metal machines are used where we have specific performance requirements that just can't be delivered through an Infrastructure as a Service environment," says Griffiths. "That's really the database side of things, because we do a lot of pre-aggregation of data, so that from a user experience you receive instant results. You need bare metal to get that level of performance."

The company also uses its own server equipment to store and deliver the 800TB of video footage in its database, which grows at the rate of 3,000 full-length HD match videos every month. "In terms of video, we've built up that infrastructure ourselves," says Griffiths. "To go to a third party and say 'we need 800TB of storage, it has to grow by this amount every month and we need certain bandwidth', the costs

would be huge. So we manage that within a dedicated hosting environment."

With customers that include many of Europe's leading football clubs, which have scouts located right across the globe, the Scout7 database must be constantly available, and the company puts a lot of effort into ensuring hardware failures don't disrupt its service. "Redundancy is inherent all the way through the environment," says Griffiths. "For example, the way we set up our hard disk arrays: if any number of disks go pop, everything will keep working. We have hot standby on the databases, so if something goes down we'll always have good service with the other one. We have off-site backup of the video archive, so that the entire archive is reproduced in a geographically separate location."

Griffiths says the next step for Scout7 is working with partners to bolster its databases with even more information. Clubs don't want to log in to different systems to get players' medical records, for example, they want it all in the one place. Griffiths says the company is looking to partner with other software providers so it can collate that information: "We accept we can't do everything ourselves." Football is a team game, after all. **BARRY COLLINS**

What about you?

Do you work for a British technology company that could be profiled in PC Pro? If so, get in touch: profile@pcpro.co.uk



Viewpoints

PC Pro readers and experts give their views on the world of technology

Please – next time I forget my password, let it be forever

Computer users are opting for convenience over security. Surely there's a way to have both?



Darien Graham-Smith is deputy editor. You should ignore all messages purporting to be from him as a matter of course.

Once upon a time, I had but a single password to keep track of. My college computing account hosted my email and my personal webspace – and those were the only two services I used. That, as they say, was then. Today, a quick tot-up finds me logging in to more than 60

password-protected accounts on a regular basis. All right, I might be an unusual case, but what with social media, chat services, online shopping, banking and so forth, even the proverbial man on the Clapham omnibus is surely up in the dozens these days.

So I'm sure you'll understand when I confess that, to keep things manageable, I've ended up using the same password across most of these services. This, of course, is exactly what security experts advise against, and I wouldn't dream of arguing with them. But as long as you keep your really important credentials unique, there's a limit to how much trouble you're likely to get into. I've weighed up the possibility that someone might start posting as me on *Doctor Who* discussion forums, and I've decided that it's an acceptable risk.

Of course, there are better ways to deal with this. Password-management tools can certainly help, as long as you use them in the right way. But just as I don't want to remember scores of passwords, nor do I particularly want to manually reauthenticate myself every time I open up my laptop, and this makes the merits of the software rather moot. The thief who relieves me of my MacBook won't need to guess my passwords: he will find himself logged in to my email account automatically.

On some level I'm aware that I should feel bad about this. That I'm asking for trouble, and that when it comes, I'll get no sympathy. PC Pro staff ought to set a better example. But at the same time, I'm not alone in preferring the easy life. It's human nature. UX consultant Don Norman tells a story about a security conference he once attended where an electronic badge was needed to gain entrance to the venue – or would have been, had some helpful soul not wedged the door open with a brick. If a technology doesn't account for that universal instinct, it will never succeed – and blaming the user won't change that.

So what's the alternative? Funny you should ask. This month we've seen not one

“If a technology doesn't account for a universal instinct, it will never succeed – and blaming the user won't change that”

but two fresh initiatives aimed at reducing the password burden. The one that's made the bigger splash is "Windows Hello", a new biometric identification system that's being plumbed into Windows 10 as we speak. Drawing on fingerprint, face and iris recognition (depending on the capabilities of the hardware), Windows Hello promises to let you log in to an authorised Windows 10 device without laying a finger on the keyboard. It's not exactly a new idea, but it's a welcome addition to the platform.

Yahoo, meanwhile, has taken a more dramatic approach. It's announced that US users logging on to its email services over an unvalidated connection won't now be prompted for a password, but instead will receive a one-time code, sent to their mobile phone, which they can enter at the website to confirm their identity.

It's fair to say that Yahoo's isn't a perfect solution. Digging out your phone and transcribing a code replaces one hassle with another – and what happens if you're out of range, or your battery's dead? What, indeed, if you're one of the 30 million Americans who doesn't have a mobile phone?

Really, though, that's all detail. The significant point is that Yahoo has given up on trying to authenticate people itself, and has instead begun to rely on an external token of your identity.

That's a philosophical change that leads us to potentially interesting places – because that token doesn't have to be a phone. Another new technology in Windows 10 is a system called Passport, which lets third-party services use your Windows Hello identity to authenticate you. Soon, I might be able to pick up a colleague's tablet, smile at the camera to identify myself, open a browser and find I'm automatically logged in to my email and other participating services. It's an enticing prospect.

If there's a problem with this vision, it's the single point of failure. No system is 100% secure, and if you can somehow trick Windows Hello into logging you on as me then the whole house of cards collapses. But there's hope here too, this time from Google, which has recently been carrying out its own work on biometrics. At the end of last year, it introduced the "no-captcha recaptcha", which identifies you as a human (rather than an automated service) based on the way you move a mouse and click a button. The logical next step is for the OS to monitor the way you hold your device, or

type your name, to derive a recognisable signature that's impossible to fake.

We don't even have to stop there. What about location awareness? Android phones can already automatically bypass the lockscreen when in range of your smartwatch, or when you're in your home. Start combining such data with biometrics and we can identify you with an extremely high degree of confidence – without your needing to remember a thing.

All of this technology exists today; my hope is that it hits the mainstream before my password count hits triple digits. It's time we stopped forcing computer users to choose between convenience and security – not merely because it's a question with no good answer, but because, in reality, we all know which way most people are going to jump.

darien@pcpro.co.uk

Microsoft's new approach looks like it may pay off

Microsoft is doing everything all at once this year, and it might just prove the company's salvation



Jonathan Bray is PC Pro's Reviews editor. He dreams of one day being able to do all his jobs in parallel – and working a three-day week.

from Ballmer and Co – and the right one, I thought at the time. Then Windows 8 arrived, everyone hated it, and Microsoft's big vision for the future stalled.

After two years, it looks as if Microsoft is finally emerging from those doldrums. I've been using Windows 10 for a while now, and despite the inevitable bug here and there, I'm going to stick my neck out and give it the big thumbs up. It looks to me as if Microsoft is back on song.

It isn't the headline features that have triggered my enthusiasm. I've barely touched the new multiple-desktop mode: its usability needs a good polish first. And although I know Cortana is there, I've found little need to rouse her from her peaceful slumber. Who on Earth thought adding voice control to a desktop OS was a good idea anyway?

Instead, it's the little improvements to Windows 10 that are making the difference every day. The fact that I no longer have to install a third-party Start menu, that I can carry out keyword searches directly from the taskbar once more, and that I can live without the Windows Start screen taking over my entire monitor occasionally – all of this makes living with Windows 10 on a daily basis perfectly pleasant; far more than it was under Windows 8.

"I prefer the stripped-down interface that the Modern style demands; it allows me to focus on my work"

I've even (brace yourself) begun to use the Store to install and run Modern apps. Now that these can be run in a window, they somehow seem to make more sense. In fact, I sometimes prefer the stripped-down interface that the Modern style demands; it allows me to focus on my work.

It doesn't seem like much, does it? However, it's this comparatively trivial upgrade that could prove to be the most significant for Microsoft and its hopes of turning Windows 10 into the universal operating system. Apps have long been a sticking point for Windows 8 and its related ecosystems – the quality of them and the selection. If, by simply allowing users to run those apps in a window, Microsoft can finally spark momentum in Modern app development, Windows 10 will have done its job.

It isn't only the improvements to Windows that have me convinced that Microsoft is making a comeback, though. Elsewhere, the company is finally pulling together all the different strands of its consumer software offerings and beginning to produce something coherent.

Windows 10 for phones will launch at the same time as its desktop cousin, bringing with it the promise of apps that will run on both mobile and desktop ecosystems. This should provide further encouragement to developers who may, currently, be struggling to justify spending time and money on producing apps for a platform that nobody uses.

Office is joining the party, too. Following last year's launch on the iPad, the touchscreen apps for Word, Excel and PowerPoint are now available on Android and in the Windows 10 Store (see p73 for a detailed preview). At last, there's an official Office presence across all three of the major touchscreen platforms, and they're all pretty close in terms of their features and user interface, so you won't have to adapt to something different every time you switch from your laptop to your smartphone or tablet then back to your laptop again.

This month, we've also had our first glimpse of what's in store for the full desktop version of Office 2016 (see p74). It's early days for Microsoft's workhorse suite, but there's yet more evidence of its new laser-guided approach here, with Office 2016's new search box acknowledging the fact that desktop users might – y'know – appreciate new features aimed at them.

It's a feature that works brilliantly. Where previously I might have had to hunt around, even Google for the location of a function or setting, all I now have to do is press Alt+Q and type a search term into a text field. I've already hidden the ribbon away; hopefully, I'll never have to rummage around in its grim depths again.

Microsoft is attempting the seemingly impossible this year, with the launch of Windows 10 for desktop and phones, new touch apps, a revamp for desktop Office and a new

development model for the production of universal apps. And while this may sound like too much development for any company to manage in such a short amount of time, I think this new, multi-stranded approach is helping Microsoft maintain its focus. Let's hope it can keep it going, because I like where 2015 is heading.

jonb@pcpro.co.uk

Google, take note: garbage in means garbage out

The firm's reliance on data over which it has no control makes it difficult for us to trust its services



Nicole Kobje is Briefing and Futures editor. She advises that it might be best to rent a car in Sardinia in the winter.

I'd be lost without Google Maps. Or so I thought, anyway. On a recent trip to Italy I paid to ensure I had mobile broadband all the time, everywhere. This was almost exclusively to have the ability to search Google Maps. (You can download the maps and find

your location on GPS without data, but I also wanted to search for local restaurants, train times and the like.)

Following ten days of being delayed and confused, I feel Google owes me not only the sum I spent on mobile-data charges but a good chunk of my life back too – particularly the five hours wasted in Bosa, Sardinia, waiting for a bus that Google Maps said existed. Eventually, the paper map taped to the coffee shop that acted as the transport terminal in that desperately sleepy town revealed otherwise.

In fact, every single public transport search I ran, from Alghero to Venice, was incorrect. From the bus out of Bosa to the train leaving Pisa, the schedules, frequencies and even available lines were wrong. Eventually, I stopped using Google Maps to find my way around and simply walked to the train station. While planning my travel, I'd compare the results received from the ticket machines to what Google claimed. They never matched. Not once.

This may sound like the rant of a spoilt person – there's surely no better place to have an hour to kill waiting for



a train than in an Italian café, and yes I will have another cappuccino thank you – but if Google can't get the basics right in a country with modern, well-organised train travel, imagine how bad it is everywhere else.

It's a shame, because Google Maps is a remarkable platform: it not only tells me where I am and gives me multiple, real-time options to get where I'm going, but it also suggests places I may want to go. But the directions and suggestions I get from it are only so good as the data Google puts in – garbage in, garbage out.

Real life is changeable: you can't check the train times once a year and hope they're never altered. In the same way, if you pin a restaurant review with opening times to a map there's every chance the restaurant will be out of business six months down the line. It's the inherent problem with pulling in data feeds and accepting user-generated content: who's checking to see if it's correct, and who's checking to see when it needs updating?

This is why travel writing and word of mouth won't fall by the wayside just yet. If I ask a friend where to go for pizza in Rome, I know her suggestion is dated to her last trip. If I look at a bus schedule in a guidebook, I know it's only as good as when it was published. But search via Google Maps and it confidently tells you the next bus from Bosa is in precisely 42 minutes, when in fact it's not for another few hours.

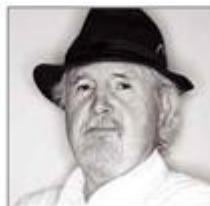
What can Google do? It could hire editors, à la Douglas Adams' *Hitchhiker's Guide to the Galaxy*, to continually update its listings, but that seems contrary to its digital, automated style and, frankly, like a lot of work. Google could surely require in its terms that data from transport authorities is up to date – I can forgive the Bosa bus boondoggle, but not the errors on the hourly Florence to Venice line – and refuse to include them if there's too many errors. For smaller companies such as bars and restaurants, Google could date the information as it does Street View images, or if it was feeling clever, fade listings out after a certain time, so proprietors would have to update them to regain their Google Maps listing.

If data is the new oil, as some analysts like to say, Google needs to tap a better source. Basing so much of its business on outdated information leaves room for rivals to step in. I've already switched to Citymapper for travelling in London, and the fantastic website Rome2rio for public transport abroad. Sorry Google, but when I get lost, you lose me.

 nkobie@gmail.com

Amazon's ebook reader suffers that syncing feeling

Kindle sales are down, but Amazon has a secret weapon – if it could just make it work



Dick Pountain is editor of PC Pro's Real World Computing section. He's considering the nom de plume "Noter Benny".

I have an interest in note-taking. Okay, some might say I'm obsessed by note-taking. This is no coincidence: all my main occupations – editing PC Pro's Real World Computing section, writing this column, writing and reviewing books – involve reading the work of others and gathering together important points. Any tool that can reduce the amount of retyping required makes a huge difference to my productivity – like weeding a field with a tractor, rather than a teaspoon.

Making notes on a tablet that can sync with my laptop has removed the need for Post-it notes flagging pages in books, but has still left me the job of retyping quotes into my own text. Over the years I've tried several of those handheld scanners, but none has proved effective enough to be worth the hassle. No, the logical final step is for the source material I'm reading to be

“ You can place bookmarks, highlight passages and make notes, but none of these functions is without its quirks ”

online too, but that's taken until now to arrive. For the very first time, I'm reviewing a book in its Kindle rather than paper edition, which means I can search its full text for relevant phrases and copy-and-paste the resulting notes and quotes. In theory, that is, because it turns out to be not quite so simple.

Amazon's Kindle reader software enables you to place bookmarks, highlight passages and make notes, but none of these functions is without its quirks, and how it works varies between versions, despite the fact that Amazon creates the software for all of them.

I like to use an actual hardware Kindle when outdoors because it's light and

readable in sunlight and has great battery life. Indoors, I prefer to read and note-take on my Android tablet, but I write the review on my Windows laptop – and all these platforms run different versions of the reader.

The first quirk I found was that the granularity of Kindle bookmarks is too broad, working only to whole page boundaries. When I view Notes & Marks, the short extract presented is only the top few lines of that page, although my interest might lie further down.

Highlights are more useful: the extract is from the start of the highlighted area, not the whole page. I can attach a note to any word on a page, but in Notes & Marks only my note's text appears, so I end up with a cryptic list such as "yes", "no", "good", "really?", with no idea what each refers to until I click it and go to that page. The best compromise is to highlight a sentence or paragraph and then attach a note to its first word.

Another quirk: notes, highlights and bookmarks should sync automatically between Kindle, tablet and desktop readers, but at first notes made on my tablet weren't showing up on the laptop. This matters because I can only copy-and-paste highlighted quotes from the laptop version, as Kindle and tablet versions have no copy function. Solving this required a trawl through the forums, where sure enough I found a suggestion – try manually syncing by hitting the curly-arrows icon. Still didn't work. More forums and the real answer. You have to hit not the sync icon inside the book in question, but the one on the homescreen with all books closed. D'oh! But it does work.

The last quirk is that you can't run multiple instances of Kindle reader on the same device. It so happens I have another book on my Kindle that's relevant to this review and I'd like to quote from it: so, I have to go to library, open other book, find quote, copy-and-paste (but on the laptop version only). It would be nice to keep two books open in two instances of Kindle reader on the same device.

I shouldn't grouse too much, though, because merely being able to search, make notes and copy-and-paste them has hugely reduced the amount of tedious retyping involved in the reviewing process, and I also need to remember that Amazon is obliged by copyright and fair usage to restrict some of these functions (a copyright notice gets added to every quote I paste, which I delete).

Nevertheless, I do believe that Amazon is missing a trick: by making a few tweaks, it would establish an effective collaborative network for students and researchers to share notes and quotes. And its Kindles could do with a jolt: post-Christmas, there were widespread stories about drooping sales figures of both the hardware and ebooks. For Amazon's own sake, not to mention addicts like me, it should take note.

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Readers' comments

Your views and feedback from email and the web

Fed up with spam

My email address has recently become known to spammers, despite the care I take in disclosing it selectively. I receive emails from loan sharks, gambling sites, PPI-recovery firms, debt-collection businesses – all of which appear to be at the leech end of the spectrum, an impression only reinforced by their failure to include unsubscribe links. They won't say how they get their information either; to suggest that disclosure isn't possible is clearly dishonest.

Our politicians, showing as much spine as is customary, have done nothing about it, failing to even initiate a service such as the Telephone Preference Service, ineffectual though that is. Anyone might be moved to suspect collusion! **Peter B Thomas**

Hard driving

Driverless cars won't happen in my lifetime. Have you seen the list of requirements that such a vehicle would have to satisfy? I doubt that there is one, and it would be a very difficult specification to write. While there are many of us who drive – and the collision rate per driver-mile must be minute – there are few of us who could get close to writing down everything that we do as drivers.

For example, last winter I saw a "keep right" sign in the middle of the road that would have taken me into the oncoming traffic. Having slowed down and assessed the situation, I ignored the sign and kept left. This was the first time I'd encountered such a situation in 50 years of driving. What computer algorithm would have given that answer, and what sensor data would it have needed? **Alan Wheatley**

Backwards compatibility

I was very interested to read Vint Cerf's warning about a "forgotten century" (see issue 247, p10). Having spent the past year scanning in all my old negatives to create a lasting memory for future generations, I was perturbed to say the least. But is it just scaremongering? I've never had trouble with backwards compatibility. Forward compatibility may be a challenge, but, for example, the ability to load previous versions of Microsoft Word has never been a problem. **Bob Oldershaw**

Star letter

I was interested to hear your comments on the *PC Pro* podcast about Apple TV. While I don't think it's a perfect system, it does a good job of letting me keep my videos and music in iTunes on a PC, to watch on my TV via Apple TV, or on my iPhone or iPad with the Apple Remote app.

The bit that's missing, in my view, is an easy way to convert my collection of DVDs and Blu-ray discs into a format that can be stored in iTunes. I'm far more likely to watch rubbish off Netflix – simply because it's so

easy and convenient – than the shows I love, which are stuck on DVD. Some searching online will point you to format-shifting tools, but they're a bit fiddly and technical, and it's only recently that the use of such tools has been declared legal in the UK.

This isn't a problem unique to Apple, however. And now that I've converted my discs to Apple-TV-friendly files and loaded the content onto iTunes, I'm enjoying my DVD collection all over again. **Chris Eason**



This month's star letter wins a Samsung 840 Evo 120GB SSD worth £70. Visit samsung.com/uk

Deputy editor Darien Graham-Smith replies: Mainstream files such as JPEGs and Word documents will surely remain readable for a long time to come. But data preservation is a real issue for anyone who uses more specialist applications, or has done so in the past – and it isn't only about software. How many of us are still holding on to historical data on floppy disks that we no longer have the hardware to read?

More unsung heroes

Your article on the unsung heroes of computing (see issue 246, p42) was particularly interesting. The ones you picked deserve all the praise you gave them, but what about the British hero Professor Tony Hoare? As a Turing Award winner (1980) for his "fundamental contributions to the definition and design of programming languages", perhaps he's hardly unsung. But Brooks, Cerf and Dijkstra are all Turing Award winners as well.

Also, in the list of nominations from *PC Pro* readers, Alan Kay is mentioned as an "innovator of object-oriented programming". Kay

openly acknowledged that he was standing on the shoulders of others when he started working with objects, and I find it odd that the two inventors of OOP aren't given a place in your article. It can't be because Ole-Johan Dahl and Kristen Nygaard were also Turing Award winners (in 2000). It must be that they really are forgotten, outside of academic computer science. **Håvard Hegna (retired), The Norwegian Computing Center**

Håvard Hegna provided a number of references detailing Alan Kay's connection to Dahl and Nygaard – including Kay's own article on the early history of Smalltalk, which is well worth a read, at pcpro.link/248key.

Windows subscription? No thanks

Windows 10 isn't going to be free: there are no free lunches in this world. I suspect Microsoft will push the price up to at least £5 per month – which is well over the average daily wage in a developing country. I can't think of any good reason why the firm should charge me more than it charges anybody else on this planet.

What if we sign up to a software-rental agreement and then some accounting error occurs? Will our computers freeze? And will Microsoft take its usual "not our fault" line and charge to put it right? Is it going to take possession of the data on my computer and hold me to ransom? Or, does the

BELLOW There are many more in the tech arena worthy of praise – including inventors of OOP, Ole-Johan Dahl and Kristen Nygaard



firm, in its arrogance, now believe the data belongs to it since its software helped create it? **Peter Roulston** (See *PC Probe*, p16, and our reader poll, opposite, for more on the subject.)

What's a watch for?

Tag Heuer's decision to launch a smartwatch has been described as a response to Apple "encroaching on its business". Really? Since when does a watch that lasts only one day "encroach" into the market for anyone who actually appreciates watches?

Give me a few nuggets of smart information built into a "real" watch, however, and I might be interested. A tiny E Ink screen on the rear of a normal watch would be great. Then when it dies I'm left with a watch that can still tell me the time – gasp! **Nila**

Aghast at Avast

What is it about Avast Free Antivirus that makes *PC Pro* reviewers think it's less intrusive than the AVG equivalent? The first time I installed Avast, I went back to AVG after two weeks because of the constant pop-ups. Now I'm trying it again and it's nagging me to upgrade and register. It has also tried to sneak in a download of the Chrome browser while updating itself.

"The first time I installed Avast, I went back to AVG after two weeks because of the constant pop-ups"

Additionally, Avast has prevented me from installing a Photoshop filter I've used for years, and won't allow me to install a Firefox plugin for an online service I wish to join. Yet in its newly updated state, it tells me that I can now "manage my PCs remotely through my Avast account". That doesn't sound secure to me.

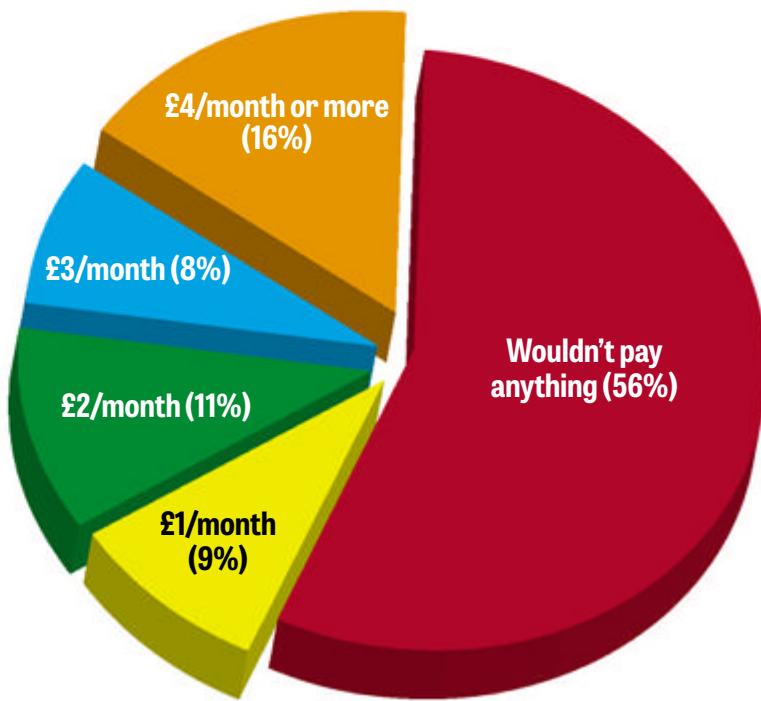
This is an irritating and intrusive piece of software. Are your reviewers receiving doctored versions for review? **Roger Whiteway**

Reviews editor Jonathan Bray replies:

Intrusiveness may be partly a matter of personal taste: I've used Avast for a long time and have never found it particularly annoying. The problems you've encountered with the Photoshop filter and Firefox plugin are unfortunate, though. Obviously we can't test every plugin or software package on the planet, but we do test for false positives, and in these tests Avast performed quite well overall. And I can assure you we don't review doctored versions of antivirus software – we download it just like everyone else!

Readers' poll

We asked you: if Microsoft were to introduce subscription fees for Windows 10, what's the maximum you'd be willing to pay for a personal licence?



It might make sense for Microsoft to offer Windows on a subscription basis (see p16), but the model certainly has its opponents – more than half of you said you'd insist on a perpetual licence, or switch to a different platform. On average, those who were willing to pay considered around £3.50 a month a fair price for personal use. When asked about the sum businesses should pay, you considered that £5 a month per workstation, on average, would be reasonable.

"£60 is fair for an OS with a five-year lifespan – so that's £1 per month"

"If your financial position changes unexpectedly, you don't want your computer to stop working as well!"

"£5 a month is reasonable if it covers all six Windows computers in my house"

"I might not upgrade my computer if the new one came with an extra cost every month after purchase"

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The HA97 PowerDAW is our most popular computer music PC. A great all-rounder solution designed for I.T.B (in the box) production duties with plenty of scope for further expansion, makes it suitable for home and pro studios alike. Sporting a 4.4GHz CPU with up to 32GB of memory as well as noise management thanks to carefully chosen components.



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- Microsoft Windows 7 Pro 64-bit

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The GW-HT20 features the 8-core Intel Core i7 5960X CPU with Hyper-Threading which we overclock to 4.2GHz. This very powerful CPU is partnered with the high-end 4GB NVIDIA Quadro K4200 graphics card. Also included is 16GB of high bandwidth 2666MHz Corsair DDR4, a 250GB Samsung SSD and 2TB Seagate hard disk.



Gaming Systems

Scan 3XS Pro Gaming systems are engineered to give you an edge over your competitors in the latest games. Each model has the perfect blend of cutting edge components to help you pwn noobs without having to break into a sweat. Our range includes powerful tower systems, miniature marvels and gaming laptops for all budgets.



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- Microsoft Windows 8.1 64-bit

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Our highly popular Vengeance gaming system is based around the immensely powerful NVIDIA graphics card, the 4GB GeForce GTX 980. To make that the GTX 980 isn't held back this awesome gaming PC also includes an Intel Core i7 4790K overclocked to 4.7GHz which is accompanied by 8GB of RAM, a 240GB SSD and 2TB hard disk.



3XS GW-HTX30

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- 32GB Crucial 2133MHz DDR4 ECC
- 4GB NVIDIA Quadro K4200
- 240GB SSD + 2TB HDD
- 3 Year Premium Warranty
- Microsoft Windows 7 Pro 64-bit

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The GW-HTX30 marks a giant leap forward in performance thanks to having two 8-core Intel Xeon E5 2640 V3 CPUs. These are partnered with a 4GB NVIDIA Quadro K4200 professional graphics card and 64GB of 1600MHz ECC Registered DDR3 plus a 240GB SSD and 2TB HDD.



3XS Graphite LG1720

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- 17.3" FullHD 1920 x 1080 screen
- 8GB Corsair 1600MHz DDR3 memory
- 3GB NVIDIA GeForce GTX 970M
- 3 Year Premium Warranty
- Microsoft Windows 8.1 64-bit

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The LG1720 is a 17.3" high-end gaming laptop that includes a choice of powerful NVIDIA GeForce GTX 970M or 980M graphics card, ensuring silky smooth frame rates in all games. The LG1720 is ready for next-day delivery and has a 2 Year Warranty.



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winning 3XS team



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3XS SYSTEMS

Prospects



Google Analytics

Improve the experience of visitors to your website **p32**

Twitter for business

Use Twitter to engage customers and gain a business advantage **p36**

Careers

Good in a crisis? You'd do well as a data-centre manager then **p40**

Boost your traffic with Google Analytics

David Court introduces Google's free web-traffic analysis tool, which lets you track how visitors use your site – and helps you find and fix the pages that aren't working so well

Whether you're running a personal homepage or a corporate website, Google Analytics is a powerful tool for monitoring the number of visitors to your site. It doesn't matter if your site gets one hundred or one million impressions per month – Google will record what every single visitor gets up to, helping you to understand and improve their experience. Indeed, we use Google Analytics on the *PC Pro* website, to gain a real-time overview of how the site is performing, and to examine how individual pages and sections of the site are doing.

If you're new to online analytics then the Google Analytics interface can seem daunting at first. But as we reveal below, you need to learn only a few simple techniques to start working out what is or isn't working on your website. This incredibly valuable data can then guide you in developing the site to attract new visitors, encourage them to spend more time browsing and have them leave happier.

Why choose Google Analytics?

There are many different web analytics providers out there. Some, such as Adobe's SiteCatalyst, charge a steep fee for the service. Others offer only basic software for free, in the hope you'll upgrade to a paid-for service at a later date. Google Analytics is a free service – at least,

until you reach around 10 million hits per month. Frankly, if you have those figures, the \$150,000 annual fee for the premium service shouldn't be a problem. For the rest of us, setup can be achieved in a matter of minutes (see opposite for our guide to integrating Google Analytics into your site).

The only real downside to Google Analytics is that it isn't the most intuitive service out there. Once you familiarise yourself with the front-end, however, you'll have access to an ocean of data that, when used properly, can effectively set out your web strategy for the next six months.

Even though Google Analytics is free, there's virtually no limit to how much legacy data you can store, so you can analyse how your site has grown and evolved over time. Here at *PC Pro*, we have analytics data going back to 24 June 2008 – with a few clicks, we can confirm that the top



ABOVE David Court is online editor of *PC Pro*

article on the site that day was "Murdoch fumes as Facebook overtakes MySpace", with 4,173 views. (Needless to say, our online presence has grown since then.)

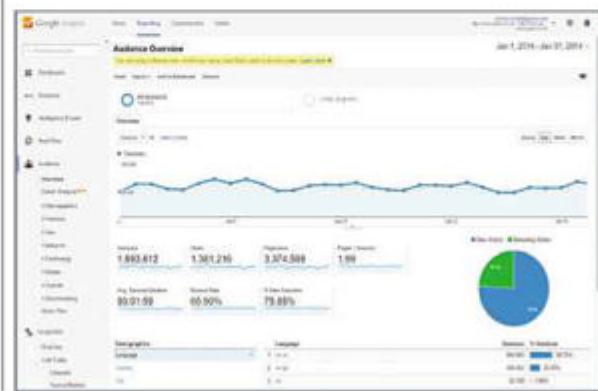
While historical statistics can be revealing, analytics can also provide valuable insights through real-time data. Here, Chartbeat is a good alternative to Google Analytics, offering easier access to in-depth data and a friendlier interface too. A basic subscription to Chartbeat costs \$299 a month – but if you think it might be right for your needs, you can find out more and sign up for a free trial at chartbeat.com.

What can Google Analytics tell me?

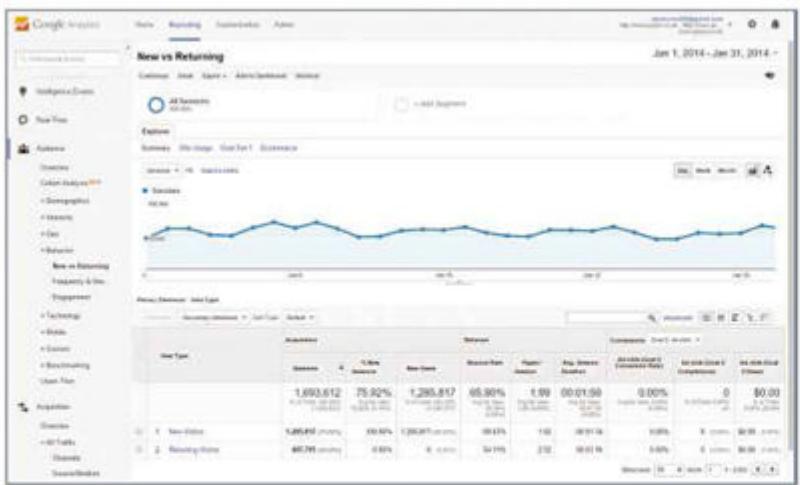
Google Analytics reports information in four key areas: your audience (how many people visited your site), acquisition (how they got to your site), behaviour (what they did while they were on your site) and real-time activity (what's happening on your site right now). You'll find all this information in the navigation bar on the left of the web page.

Let's start by looking at audience data. This is where you can find out how many users visited your site; the proportion of these that were new or returning; how many individual pages were seen by each visitor; and the average time they spent on your site.

There are also some metrics here that aren't so self-explanatory. Your



BELOW You can easily jump back in time and spot changes in visitor trends – good or bad



ABOVE A healthy rate of returning traffic is a good sign that you're doing something right

site's "bounce rate" represents the proportion of visitors who land on your site and then leave again without clicking on anything. As a general rule, a bounce rate below 50% is good – there's a lot of casual browsing on the web – but a figure above 80% suggests that something about your site, or an individual page, is driving people away, and that ought to be addressed.

The total number of sessions measures individual periods of activity on a site. Essentially, a session is recorded when a user leaves your site and doesn't return within 30 minutes (you can adjust the timing by going to Admin | Property | Tracking Info | Session Settings), or is simply inactive on your site for that period. The easiest way to understand this is to picture a visitor spending 29 minutes clicking around your site. During this time they follow multiple links, navigate to several different pages, and then leave. Google Analytics counts this as one session. If the user had gone away for 30 minutes or longer at any point, and then returned and continued interacting with your site, this would be registered as two sessions.

Session data helps you understand how many pages users view on a visit to your site, which can be useful in deciding – for example – how often to serve full-page promotions to a visitor. Serving a fresh promotion or advert to a user every five pages might annoy them if they skip pages in quick succession; doing so on a per-session basis is likely to give you more clicks and be less annoying.

You can drill down even further into your audience. Within two more clicks you



ABOVE Browser statistics reveal whether your users are mostly mobile or on desktop platforms

can find out where in the world visitors are accessing your site from, who their broadband provider is, and what OS or device they're using, as well as the distribution of age and sex. This sort of information can be particularly valuable when it comes to tailoring your content or advertising to suit the right demographic.

Acquisition

Acquisition data refers to the origin of your audience. This doesn't mean where in the world they're located (that's under Audience, as mentioned above), but rather what online source directed them to your website.

If you've paid for an SEO (search-engine optimisation) company or social-media guru to overhaul your



ABOVE Acquisition data reveals how many visitors to your website have been directed there by a web search, and how many come via other routes

site, this is a section on which to focus closely. This tab tracks which websites your users were visiting before they followed a link to your site, and filters this information into four types of acquisition: organic search, direct traffic, referral traffic and social.

Organic search basically means through search engines. If someone has landed on your site from Google, Bing, Yahoo, or even Lycos (it does still exist!) then it will be recorded here. Direct traffic is when a user arrives on your site with no previous browsing activity – in other

How to install Google Analytics

All you need to set up your free Analytics account is a Google login and a small snippet of tracking code. This can then be embedded on your site with only a basic grasp of HTML and a little bit of time, after which your site statistics will be visible in the main Google Analytics interface.



1 Create an account and sign in

Start by going to google.co.uk/analytics and signing in with your Google account (or creating it, if you don't already have one). Next, select the Admin tab at the top of the page. Click on the Account dropdown menu and select "Create new account".

2 Choose what you want to track

You'll then be taken to a page that asks: "What would you like to track?" Here you have to enter some basic information about your account and website. This information is primarily for your own reference. When you're done, click the Get Tracking ID button.

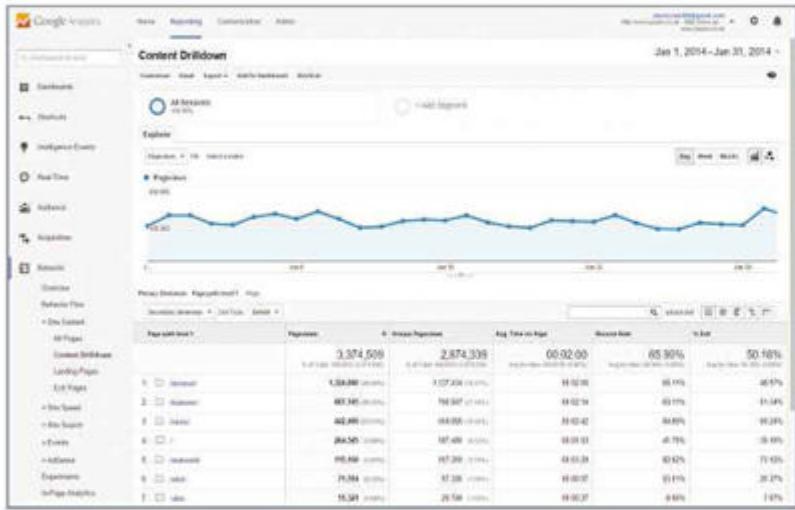
3 Insert tracking information onto your site

You'll be prompted to accept the terms of service; once this is done, a new page will appear with your unique Tracking ID and Tracking Code. You'll need to copy this code and paste it into every page of your website that you want to track (Google recommends placing it directly before the closing /head tag).

Adding code to multiple pages at once

If your website uses dynamically generated pages, you may be able to simply add the tracking script to a standard header or footer, and have it automatically included in every page that's served. If your site is based on WordPress, there are numerous plugins that can help with this. If not, we recommend downloading the free program Notepad++ and using its "Search | Find in Files..." feature to find all occurrences of </head> in your HTML files and insert the tracking code immediately before it. Don't forget to include </head> at the end of your "Replace with:" text.





words, when they type in your web address by hand, so you can expect your homepage to get the bulk of this direct traffic. It's advisable to take this figure as a guide rather than fact, however, since it's thought that Google Analytics counts any source it can't properly trace as direct traffic.

Referral traffic represents links from other web pages. This can be misleading, since big aggregating sites such as Google News and Reddit are shown here, so the line between search results and referrals can be a bit blurred. The last acquisition type is social. Here, you can see how much traffic comes via social networks, as well as discovering which of your pages are most popular on each platform – that is, Facebook, Twitter, LinkedIn and so on.

Knowing where your traffic is coming from can help you make decisions on how to market your website. For example, if you see that a huge proportion of your traffic comes via Facebook, you might want to investigate why that is, and see if whatever is driving your success can work for other types of traffic too.

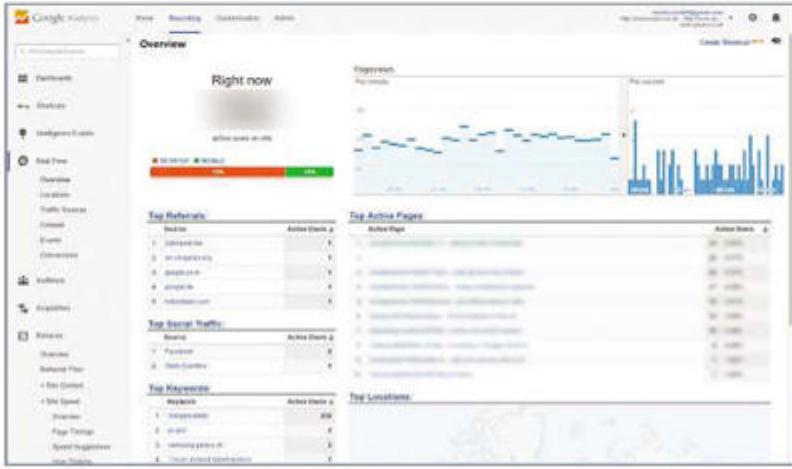
Behaviour

Google Analytics' behaviour data lets you see which pages on your site are attracting lots of visitors, and which are less popular. You can track the exact number of views and users each page has received, and if your site has an internal structure then the taxonomy view – also known as the site map – lets you see how each individual section of your site is performing.

Under the heading Site Content, you'll see four options. You can choose to view either page URLs or titles; if you want to see a list of your top articles, click on the All Pages tab. Here you can see view counts for individual pages, plus details of unique views, the average time spent on each page, entrances, bounce rates and exit percentage. If you're looking for traffic information from a specific page, an easy way to find it is to paste its address (minus your domain name) into the search box.

The content drilldown tab lets you see how entire sections of your site are faring. On pcpro.co.uk, for example, we can see how many users are visiting our reviews section, versus the number heading to our in-depth section. Such data can help you make decisions about where to focus your efforts and resources – for example, you might choose to invest in shoring up a section that isn't as popular as it should be, or focus your energy on the parts of your site that receive the most attention.

For the more advanced user, the next two sections will be important. These are the Landing and Exit pages tabs. Landing pages are simply the pages to which users are arriving to your site, while exit pages are the last



LEFT Content
Drilldown is one of the most valuable metrics, revealing at a glance which pages are performing best

ones people visit before leaving your site. Any pages that stand out in either section deserve close attention, since these may be driving up your overall bounce rate.

One final section worth paying attention to is the Site Speed tab. We recommend you sort the results on this page by average page-load time, and try manually loading the slowest pages in a separate web browser. Visitors will lose patience if a page doesn't appear almost instantly, so if you feel the page takes too long to load, consider reducing its complexity or reducing the size of images.

Real-time analytics

Google Analytics' real-time data can give you a "right now" count of active visitors to your site – and you can also investigate further into who's doing what. On the overview page you can see stats regarding top live referrals, active pages, social traffic, top locations and top keyword searches – although Google has started hiding a large percentage of this data to discourage click-chasers from gaming the system. (You can also access real-time statistics under the Behaviour tab, but that's fiddly and the data returned isn't particularly easy to read.)

It's easy to make too much of live

"Knowing where your traffic is coming from can help you make decisions on how to market your website"

statistics. If you're in charge of a website, you shouldn't make any decisions based solely on a single snapshot of visitor activity. However, real-time data gives you a valuable glimpse at what content is the most

popular at certain points. Unexpected patterns of activity can also expose bugs: many commercial sites keep a live analytics view running on a dedicated terminal at all times. We've certainly found that this approach can bring server-based errors or broken links to our attention before many automated services.

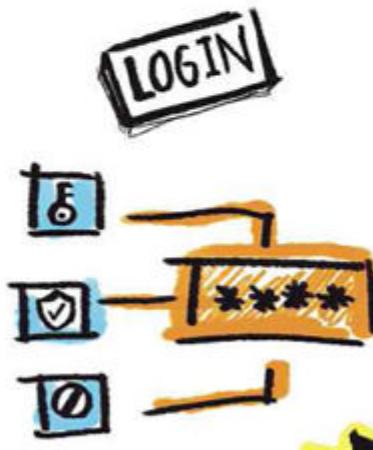
The great thing about Google Analytics is that all the information about what your site is and isn't doing is gathered automatically. You don't need to lift a finger to build up an invaluable store of data that can guide you to making informed changes to your site. And, of course, if the changes you make don't have the desired effect, you'll be able to see it rapidly via Google Analytics' real-time reports, so you can revert back before serious damage is done.

On the plus side, if your data-led changes do work – and there's no reason they shouldn't – Google Analytics will confirm it through presenting ego-boosting graphs... which you can then use to continue making your site even better. ●

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Use Twitter like a pro – and build your business

Dave Stevenson explores how Twitter – used correctly – can bring your business closer to its customers

Twitter seems like a simple way for businesses to connect with their customers: just type in a message and send. But it's easy to get it wrong. Tweet at the wrong time of the day and your message will be missed. Use the service as a one-way advertising channel and your audience will drift away.

And those are the relatively benign pitfalls. Allowing employees to tweet on behalf of your organisation can lead to trouble, as retailer HMV found in 2013, when a group of former employees took to the company's feed to complain about mass firings.

Used in the correct way, however, Twitter can be a positive tool for your business. Here, we look at what you should tweet and when, plus power-user tricks such as scheduling tweets to hit your followers at the best times, and the tools you need to manage your organisation's social media needs.



■ Building a following

Signing up for a Twitter account is simple, but finding the right username for your business may not be: with half a billion users signed up, there's a chance your preferred option will have gone. Twitter won't help you claim a name that's already been taken unless it thinks the encroachment is misleading, and buying a username from someone

else is forbidden. There are stories of organisations doing it without consequences, but failing that, a bit of creativity (adding an underscore, or appending UK, for example) should find you a unique handle.

Once you start tweeting, you want to get your tweets in front of as many people as possible. Building followers is best achieved "organically", by replying to fellow Twitterers with relevant information or joining conversations. For example, an office furniture supply company may search for "what chair?" and weigh in with advice

and offers to potential customers.

There are other ways to grow your followers. Some Twitter users simply follow vast numbers of people in the hope they'll get a reciprocal "follow-back". This isn't a good look, though: following a huge number of irrelevant accounts smacks of desperation, and the ones who do follow back are unlikely to be genuinely interested in your message anyway.

Growing a Twitter account organically takes time, but the result is more valuable.

■ Allowing employees to tweet on behalf of your organisation can lead to trouble, as retailer HMV found in 2013*

LEFT SocialBro's "Best time to tweet" report highlights when your followers are most likely to be online

The screenshot shows a web-based application for analyzing Twitter engagement. At the top, there's a navigation bar with links like Home, My Community, Monitoring, Trends, Analytics, Engagement, and Target. Below that, a section titled 'Best time to tweet' is displayed, with a sub-section 'Quick Test'. It says 'How to customize your Best Time to Tweet Report with SocialBro'. A large button labeled 'GENERATE THE BEST TIME TO TWEET REPORT' is prominent. To the right, there's a preview of the generated report, which includes a chart and some text. At the bottom, there's a footer with links for 'Custom BTTR', 'Report: Best time', 'Your account @DaveStevenson', and 'Logout'.

■ What to tweet

Twitter can serve as a reminder to followers of your existence, but alone it won't keep people following. Your tweets need to offer followers something valuable or interesting. Special offers, announcements, introductions to key members of staff – anything that rewards your followers or helps personalise your business can be useful.

Don't be too stiff, either. Twitter is a conversational medium, so feel free to chat, ask questions and retweet items you think your followers will appreciate, even if they're only loosely relevant to your core business. Web service Buffer (bufferapp.com) can help: its primary role is to let you queue up tweets for scheduled posting, but it also highlights existing tweets from users it thinks will fit with your normal subjects.

In certain circumstances, a picture can have far more impact than 140 characters. You might simply want to post a photo of the office cat to brighten your followers' day, but you can also use images to post messages that wouldn't fit into a tweet. For instance, if you're tweeting to advertise an upcoming event, you could tweet the specifics ("The company CEO will take to the stage at 2pm"), then attach an image spelling out more details of the event. Don't go overboard, though – big blocks of text won't be appreciated.

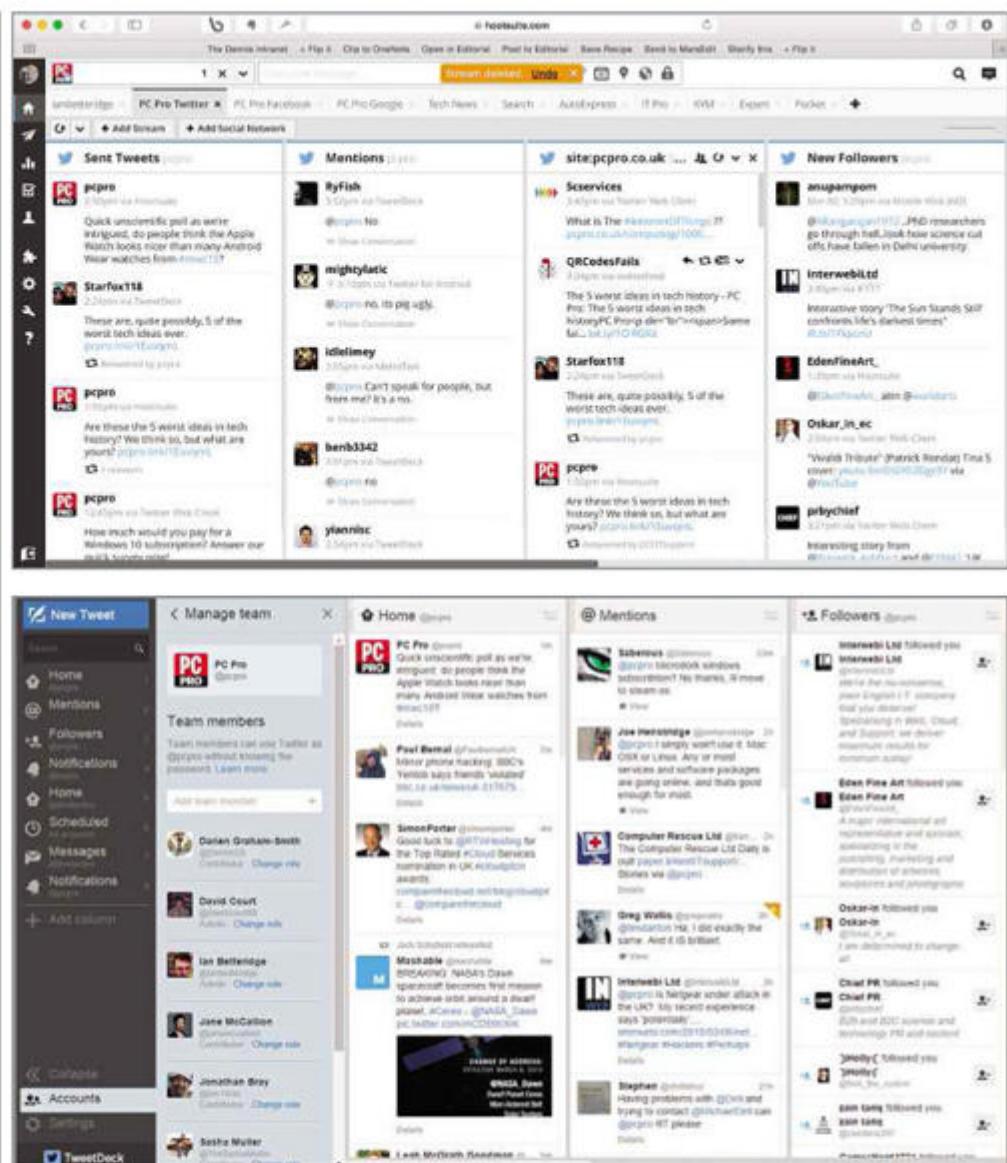
Note that if your picture is too big, a letterboxed preview will be shown, and users will have to click to see the full picture. Give your images a 2:1 aspect ratio, such as 1,024 x 512, and the whole image will be immediately visible in the timeline.

Targeted tweets with TweetDeck and Hootsuite

Thanks to Twitter's open API, there are plenty of apps available to help you get the most from the service. These range from the basic – those that allow users to see their Twitter stream without opening a browser window – to advanced client suites that support multiple users and let you schedule tweets and track how followers engage with you.

One of the most popular clients is TweetDeck (tweetdeck.twitter.com). Originally third-party, it was bought by Twitter in 2011, and presents data in an easy-to-navigate format. The main column, Home, shows the tweets sent by your followers, while Notifications rolls your mentions, replies, new followers and favourites into one handy stream.

What's great about TweetDeck is that you can add your own columns, including real-time search results for specific phrases. To set this up, click Add Column | Search, then type the word or phrase you want to search for and tap Enter. You'll see a dialog box allowing you to refine your new column: you can exclude certain words, for example, or limit search results to show only tweets that have been retweeted or favourited a certain number of times. The obvious approach for businesses is to have a search column for your company



ABOVE TweetDeck, top, is easier to use, but Hootsuite delivers more corporate power features

name. That way, if a user "subtweets" you – that is, uses your company name rather than your username – you'll see their tweet anyway.

TweetDeck also allows you to schedule tweets, so you can time your posts for when you think you'll get the best results (more on this below). You can schedule as many tweets for the future as you like, and they appear queued in the Scheduled column, so

you can keep an eye out for typos or information that becomes out-of-date. Scheduled tweets are stored server-side, so TweetDeck doesn't need to be running at the time your tweets are scheduled.

If you want multiple members of your team to be able to tweet, you can do this from here too: click Accounts | Team, and you can enter the username of those you want to have access to your Twitter account. Two levels of access are offered: admins and contributors. Both can write new tweets, and follow and unfollow other

accounts; admins are also able to add new members to the team and remove old ones. No-one can change your Twitter login credentials, and access can be revoked at your discretion, protecting you from rogue employees, and from having to change your Twitter password every time you want to remove someone.

For larger organisations, rival client Hootsuite (hootsuite.com) offers significantly more power, although with a steeper learning curve. If you have a number of messages to schedule, for example, Hootsuite allows you to import your tweets as a CSV file: the first column stores the date and time your tweet should be broadcast; the second the tweet itself; and the third any links you wish to append.

Hootsuite also gives you the ability to run a team with differing levels of access to an account, although for this you'll need a Pro account, which costs around £7 per month. It works by setting up an "Organisation" to which other members can be added; in this

"Advanced client suites support multiple users and let you schedule tweets and track how followers engage with you"

way, your Twitter account details don't need to be dished out, and permission to access accounts can be assigned and revoked as people join and leave your company. (See right for our guide to setting this up.)

With Hootsuite's Enterprise subscription (price on application), you can do even more: tweet approval, for example, allows you to sign off on tweets before they're published, so you can stop the office intern accidentally tweeting from the company account on a Friday night.

Understand your audience

The basic principles of how to tweet are universal: keep your messages conversational, react to people who get in touch with you, and avoid repetitive sales messages. What's more difficult is finding the right balance for your particular business. For example, received wisdom tells us that 9am, midday and mid-afternoon are good times to tweet, but if you're trying to reach a market of students or travellers, mid-morning and early evening may work better.

Although Hootsuite includes analytics tools, at a cost of \$1 (about 65p) per month, you'll probably want to first make use of free third-party services to help you understand how, when and why your followers react. One way to gauge engagement is to create a free account with bit.ly and use it to shorten every link you post. You can then check your bit.ly account to see how many clicks each link attracts. For TweetDeck users this is easy, as you can opt to use bit.ly as your default URL shortener.

SocialBro (socialbro.com) also offers analytics tools for free. You can define your follower base by gender, location, language and more. You can also view a breakdown of your Twitter "community", revealing which of your followers has the biggest following – and therefore highlighting the followers with whom you should build relationships.

SocialBro can help you with timing your tweets too: its "Best time to tweet" reports illustrate when your followers are most likely to be online, in particular when influential followers are online. Tag clouds can show you the kinds of subjects your followers are tweeting about to offer guidance on what to write.

With plenty of automation on offer, it may be tempting to queue up a few weeks' of tweets, but to get the most from Twitter, a combination of scheduled and impromptu tweets works best. If your followers feel your feed is being run by a PC, they won't be motivated to tweet back or retweet. A small, engaged audience is better for business than a large dormant one. ●

Set up a Twitter team with Hootsuite

1 If you're new to Hootsuite, you'll need to enable your Twitter account on the service. Click "Add Social Network" and follow the prompts to authorise your account. You can now add a few columns to your first stream, or try scheduling a few tweets. Your next task: relieve yourself of some pressure by adding a fellow contributor.

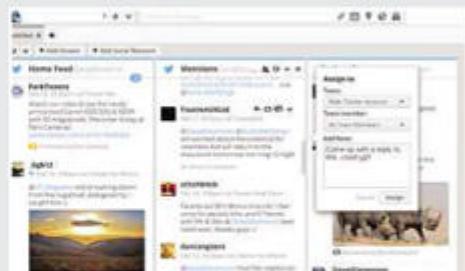
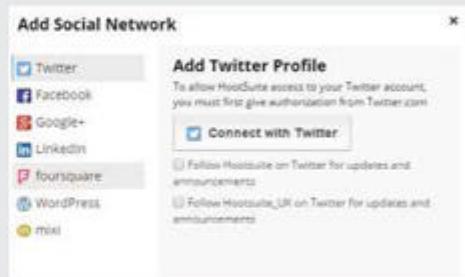
2 To work with other contributors, you'll need to define an organisation. Click your profile icon in the top left of the Hootsuite window and choose "Start collaborating with others". This will prompt you to create an organisation; enter your company name, choose an image, add your Twitter account, and click "Create Organization".

3 An organisation contains individual teams, which in turn contain individual members. You'll need to click "Add a Team" even if you have only one other person working on your Twitter feed. Click "Add a Team" and fill in the blanks. It's a good idea to upload an avatar icon for your team – blank icons can be disorientating.

4 Hit "Create Team" and you're ready to invite your first additional user. You can choose whether they have a default or an admin account: admins have the power to add and remove new and old members. If your new user doesn't have a Hootsuite account, they'll receive an email inviting them to create one.

5 As an admin, you can now divvy up Twitter tasks. For example, hover the mouse pointer over a recent reply and click the down arrow on the far right. You can now assign it to an individual team member (or the entire team). Appending a note will let your team know what it's expected to do; they'll receive an email notification once you click Assign.

6 Hootsuite can schedule tweets to coincide with events or news to which you want your followers to respond. Click the Compose textbox at the top of Hootsuite's main screen, then click the calendar icon. Choose "Try the bulk message uploader", then "Choose File" in the subsequent window. You'll need to have your tweets prepared in the required CSV format.



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Mark Wood

Data-centre manager



■ What does the job involve?

I work at Fasthosts Internet, where I'm head of operations essentially. I'm responsible for keeping the data centres powered and cooled, as well as installing and removing hardware. It sounds simple, but it's a big job: we have two data centres, one in our main premises that has 60 racks, and another dedicated data centre with more than 170 racks spread over two floors.

It's also a constantly evolving job, as the equipment is upgraded frequently. It's my responsibility to plan and ensure there's enough space and power for everything. There's a lot of maintenance involved too – I test devices such as air conditioners, uninterruptible power supplies, emergency generators and so forth.

■ What skills do you need?

There's a lot of planning involved – you need to think logically. That said, it also helps to be flexible and have the ability to think on your feet. You might be geared up to install a new set of servers, and then a last-minute change comes down the line – perhaps a supplier is swapping the hardware it uses, or a manufacturer has run out of stock of a certain type of hardware and we have to find an alternative. Although this doesn't happen often, it helps to be calm in a crisis.

A good grasp of the underlying infrastructure of your systems is essential. When things go wrong in the data centre, it's usually serious, in terms of critical services going down. You have to be ready to get your systems back up and running quickly. Thankfully this doesn't happen too often either!

■ What does your day look like?

No two days are the same. Some days, I'll be in front of my PC working on spreadsheets, capacity planning, raising purchase orders and so on. On other days I might spend time getting hands-on with the servers and cabling; I supervise this personally, because pulling one wrong cable could create an incident. My team is still quite new to this aspect of work, but it's learning, so over time I should end up doing less and less of this type of work.

■ What attracted you to the job?

It's fair to say that the data centre found me, rather than vice versa. Before taking on the role, I spent around ten years in various systems-support roles, which included regularly helping out in data centres. This naturally led to an offer to take up a position as a full-time data-centre engineer. Within a couple of years I'd worked my way up to manager.

■ How technical is the role?

As I've mentioned, knowing your own systems inside-out is valuable, so you can apply quick fixes if need be. My team and I also help out with hardware diagnostics and replacing server components, so a good grounding in hardware is useful. I often still use my network knowledge when diagnosing cabling connectivity issues too. I dare say a more hands-off data-centre manager might not use those sorts of technical skills, but I find them useful.

■ What are the working conditions like?

The job can be stressful at times: I'm always aware that if something goes wrong in the data centre, many people's work can be affected. Some jobs can only be carried out overnight,

to minimise disruption, so the hours can sometimes be antisocial. In fact, due to the 24/7 nature of data centres, you have to be prepared to be called on-site in an emergency. Wherever I am, I'm never too far away from my work mobile, although I can only recall two out-of-hours incidents in the past 12 months – so it isn't too bad. And I love what I do, so that really balances out the stress.

■ How would someone get into this career?

Having an IT background certainly helps, but a lot of day-to-day functions are process-driven – for example, we receive automated requests to rack new servers when stocks start to run low, and, conversely, we're prompted to remove old servers once a customer has finished with them. So you require little in the way of formal knowledge to get started; you just need an ability to learn and apply yourself. When it comes to climbing the ladder, the prime requirements are experience and exposure to real environments. There are training courses available, but nothing compares to hands-on experience.

■ What's the pay like?

Pay in the sector generally seems to be pretty good. Employers realise the huge responsibility involved, so they don't skimp on salaries – it would cost them a lot more in the long run to hire inexperienced, unmotivated staff who couldn't be relied on to keep things running smoothly. ●

£55k

Approximate
starting salary

30

Permanent jobs
(itjobswatch.
co.uk)

£70k

Average
earnings

Where to start

■ DatacenterDynamics (datacenterdynamics.com)

■ Data Centre News (datacentrenews.co.uk)

■ CNet Training – global data centre and network infrastructure education framework (pcpro.link/248train)



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88 BEST APPS

**From productivity tools to crazy games,
we bring you 88 essential downloads for
all the major mobile platforms**

Contributors: David Court, Darien Graham-Smith, Vaughn Highfield, Jane McCallion, Adam Shepherd

iOS

Apple invented mobile apps as we know them, and the iTunes App Store now hosts a tremendous range of games and creative tools, all designed to take advantage of Apple's powerful processors and superb displays. Thanks to strict security policies, there are still some things you can't do on iOS: you're restricted by how much you can customise its look and feel, and you have limited access to the local file system. If you want to get your hands dirty, you'll have to jailbreak your device.

For most of us, though, the whole point of iOS is that no tweaking is required. It's a slick platform for productivity, creativity and good old-fashioned fun, and all the apps we've chosen here work on both iPhone and iPad.

DRAGON DICTATION

Free

Siri does a fine job with voice commands, but Dragon Dictation goes much further, allowing you to dictate documents and emails.

The process isn't quite seamless. iOS's security model prevents Dragon Dictation from interfacing directly with other apps, so if you want to dictate into (say) Evernote or Pages, you have to talk to the Dictation app, then copy and paste the transcribed text into the place you actually want it to be.

Emails can be sent from within the app, however, and you can optionally connect Dragon Dictation to your social networking accounts, enabling you to dictate tweets and Facebook status updates.

Although better system integration would be nice, we can't really blame Dragon Dictation for that – and its speech recognition is impressively accurate, even without any training. If you need to get a large quantity of text onto your iPhone or iPad, it's certainly far more pleasant than using the virtual keyboard, and it won't cost you a penny.



ESSENTIALS

GOOGLE

Free; also on Android, Windows Phone

The official Google app doesn't just search: it's your gateway to Google Now, pre-emptively presenting information from directions to sports results. It also supports "OK Google" voice commands to carry out searches and set reminders – just don't tell Siri.

SHAZAM

Free; also on Android, Windows 8, Windows Phone

Shazam can identify a song in seconds, from a database of more than 11 million tracks. The basic function is built into Siri, but the app offers additional features, including read-along lyrics and auto-recognition of the tunes you hear while you go about your business.

FILEBROWSER

£4.49

You might assume that FileBrowser lets you browse the files on your iOS device. Actually, it's far more useful – it lets you browse, move and open files from other devices on your network. It's a breeze to stream music from your desktop PC, or play video from a NAS drive.

CHROME

Free; also on Android, Windows 8

Safari is a fine mobile browser, but if you use Chrome on your desktop or laptop, it's a no-brainer to install it on your iPhone or iPad too. Your saved passwords and bookmarks will be synced across devices, and you can use less data too, with an optional compression proxy.

SPOTIFY MUSIC

Free; also on Android, Windows Phone

Storage space can be tight on an iPhone; Spotify's mobile app lets you stream music instead. However, if you don't pay for a £9.99-per-month subscription, you're limited to shuffle play, and those 96Kbit/sec streams can make a dent in your mobile data allowance.



SWIFTKEY KEYBOARD

Free; also on Android

Apple's virtual keyboard is fine for tapping out the odd text message, but let's face it – for anything more ambitious, it isn't ideal. As we've already mentioned (left), one solution is to dictate instead of typing. Another is to switch to a different type of keyboard.

SwiftKey brings together two clever input technologies. "SwiftKey Flow" lets you type by sliding your finger across the virtual keys, rather than having to tap each one in turn. Even if your swiping isn't 100% precise, SwiftKey does a startlingly good job of identifying the word you meant.

Based on what you're typing, SwiftKey also uses a built-in linguistic database to intelligently work out which words you're most likely to want to type next, and presents the top three candidates as time-saving single-tap options. For even better accuracy, you can let it learn from your Facebook and Google+ accounts.

Coupled with SwiftKey Flow, this predictive approach turns text entry from a chore into a breezy process that's faster than even using a real keyboard. Why the developer's giving it away for free, we have no idea.





iOS

MINECRAFT – POCKET EDITION

£4.99; also on Android, Windows Phone

Minecraft is a phenomenon. Not so much a game as a creative workshop, it invites you to mine materials to assemble your own buildings and items – and the investment of time involved makes it the ideal app to pick up in spare moments.

If you're already a Minecraft addict, it's important to note that the Pocket Edition doesn't include all the features of the full game. Nevertheless, there's a huge range of materials to play with, plus a decent selection of animals and monsters populating the world, and Mojang regularly updates the game with new features. It's no surprise that this is the most popular edition of the game, and if you're new to the joys of Minecraft, it makes a fine introduction.

TOMTOM WESTERN EUROPE

£38.99; also on

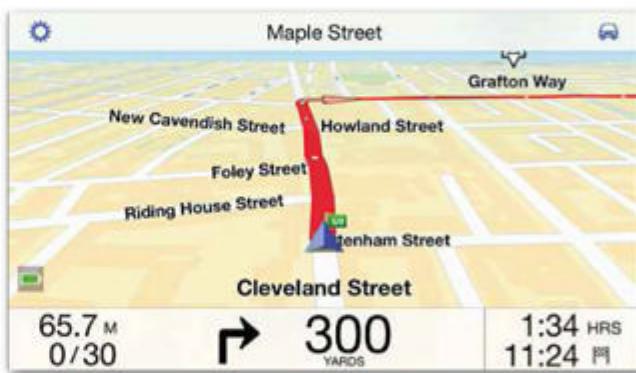
Android

With several free map services now offering live driving directions, you might hesitate to pay almost £40 for the TomTom app. What you get for your money, though, is a far more versatile offering.

For a start, it uses offline maps, so you're not reliant on a mobile signal; you can drive all over

Western Europe without racking up data-roaming charges. The purchase price includes map updates for life, and you also get TomTom's excellent IQ Routes, which draws on real-world traffic data to get you to your destination as smoothly as possible. You can also share routes and your location with friends, and multitasking support means a meddling passenger won't make you miss your turn-off.

Note that Wi-Fi-only iPads will need an external GPS receiver for route planning, which costs more than the software itself (around £90). If offline navigation isn't a priority, consider the surprisingly capable – and free – Google Maps app as an alternative.



VSCO CAM

Free; also on Android

VSCO Cam upgrades the standard iPhone camera app to give photography enthusiasts full control over the shutter speed, ISO and white balance – as well as letting you choose focus and exposure values from separate areas of your frame.

Once you've captured the perfect image, you can apply a range of filters with adjustable strength. Manual post-processing tools let you apply exposure correction, deskew images, adjust colour temperature and more. What makes VSCO Cam stand out is that these edits are non-destructive, so you have full freedom to experiment and perfect your image. When you're done, you can share your creations on an online gallery.

The iPad app doesn't offer the full range of manual camera controls, but images can be synced between multiple devices, so you can shoot on your iPhone then edit on the big screen.



PAGES

£7.99/free

Users of recent iOS devices can download Apple's mobile word processor for free (as well as Numbers and Keynote); for those on older devices it's £7.99 – but still well worth it. All the features you'd expect are here, including full control over text formats, tabs and indents, as well as images, tables and charts – and the all-important Undo feature.

File syncing via iCloud and iTunes means you can easily share documents with other devices and computers. The files you create are fully compatible with the OS X Pages application, but the app can also read and write Word documents, as well as exporting PDF and EPUB files. You can send documents to other cloud apps such as Google Drive and Dropbox for sharing, or print them to any AirPrint-compatible printer.



ADOBE PHOTOSHOP TOUCH

£7.99 iPad; £3.99 iPhone; also on Android

Photoshop Touch comes in two separate editions – one for the iPad and another with an interface that's optimised for the iPhone – but both offer a powerful selection of image-editing tools. You can import images from your camera roll or elsewhere, then work on them in layers, apply adjustments and effects, and manipulate them using familiar tools such as the Clone Stamp. Predictably, the app integrates with Adobe's Creative Cloud service, so you can send your creations back and forth between the mobile apps and the desktop application. You can also upload images directly to Facebook and Twitter.

If you're looking for an easy photo-enhancement app, try Photoshop Express instead: Photoshop Touch's extensive toolset comes with a steep learning curve. However, its uncompromising creative potential makes it a compelling choice for enthusiasts and professionals who want to take image editing into their own hands.

CALORIE COUNTER & DIET TRACKER BY MYFITNESSPAL

Free; also on Android, Windows Phone

Many of us could stand to lose a few pounds, but calorie-counting is a drag. MyFitnessPal makes it easy: tell it how much you want to lose and it works out a diet programme just for you. You can then search its database of more than five million foods to choose healthy options, and tap to record what you've eaten.

The app keeps a running record of your daily calorie intake to help you stay on course, while charts and reports let you track your progress and project forward to your goals – which is great for motivation.

What's more, MyFitnessPal also tracks your physical activity, with support for more than 350 types of exercise, plus integration with the iPhone's pedometer and a range of third-party devices and apps including Fitbit, RunKeeper and Strava. If you've been meaning to get in shape, but struggling to find the motivation, MyFitnessPal is the answer.

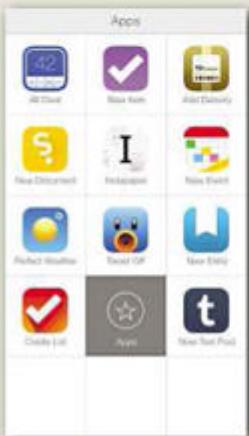
LAUNCH CENTER PRO

£3.99

If you're an iOS power user, the one-button, full-screen approach can slow you down. Launch Center Pro lets you automate your actions frequently, such as sending an email to a particular person, or applying a particular filter before uploading an image to Facebook.

A sharing system helps you get started quickly by drawing on pre-rolled shortcuts. The publisher's samples include a script to find the nearest Mexican restaurant, and another to calculate the tip at the end of the meal.

If you've used IF (formerly IFTTT – see p52), all of this may sound rather familiar, and the good news is that Launch Center Pro can act as both a trigger and an action for IF. This means you can combine that service's broad support for apps and services with Launch Center Pro's much deeper app integration.



CYCLEMETER GPS

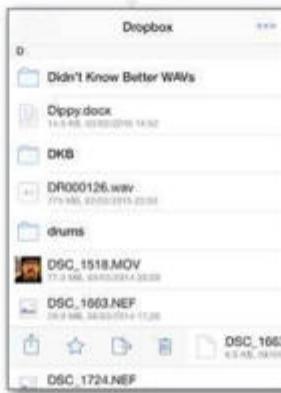
£3.99/yr

The free edition of this cyclist's app offers basic route tracking, but £3.99 per year gets you terrain and traffic data from Google Maps, weather and biometric recording, and integration with iOS Health and other apps.

DROPBOX

Free; also on Android, Chrome, Windows 8, Windows Phone

iOS doesn't make it easy to share files with other platforms. Enter the Dropbox app, from which you can easily open any cloud-synced file, no matter where it originated.



EASILYDO ASSISTANT

Free; also on Android

A slick rival to Google Now, EasilyDo brings you important information from your calendar, email and more. It integrates with Evernote, Facebook and Instagram, and includes powerful contact-management tools too.

FOOTBALL MANAGER HANDHELD 2015

£6.99; also on Android

Carry your first XI in your pocket with this engrossing football-management game. The latest release features an upgraded game engine so you can watch your matches unfold, and more detailed stats than ever.

HUNGRYHOUSE

Free; also on Android

This fantastic app not only shows all the local takeaway restaurants that deliver to your area, it lets you

browse their menus, place your order and arrange delivery – all without leaving the app.

apart from the rest. Simply swing the clock hand to see how the forecast develops over the coming week.

ICONICAL

£1.49

You don't have to jailbreak your device to give it a fresh look. Iconical replaces your app icons with new ones of your choosing, and you can also create custom icons that launch specific app actions.

IKAOSSILATOR

£14.99

This fun, inspiring app makes it easy to create upbeat dance music at the swipe of a finger. Layer drums, synthesisers and samples, then export your creations to GarageBand, SoundCloud or anywhere else.

LASTPASS

Free; also on Android, Chrome, Windows 8, Windows Phone

Our favourite password manager offers extensive features and form-filling capabilities. It also supports Touch ID, and it will run on every device you own.

REDLASER

Free; also on Android, Windows Phone

This barcode reader identifies a vast range of products (via both UPC and QR codes) and links you to online reviews and prices. It can also store your loyalty cards and build a shopping list.

MONUMENT VALLEY

£2.99; also on Android

This sumptuous game invites you to explore beautiful worlds of Escheresque scenery. You might finish it quickly, and end up paying another £1.49 for additional levels, but you won't regret it.

TWODOTS

Free; also on Android

The idea is simple: join a set number of dots together within a set number of moves. But the levels quickly become fiendish – and the game tantalises you with limited lives that take 20 minutes (or a small payment) to replenish.



LUCKY VOICE KARAOKE

Free

Build your playlist from an online library of thousands of backing tracks – then, when the party starts, buy a day pass for £1.49 and sing your heart out. Sync the app with an Apple TV for big-screen entertainment.

NATIONAL RAIL ENQUIRIES

Free; also on Android, Windows 8

Train timetables aren't exactly scintillating, but this friendly app lets you search for the services you need, along with pricing information, live updates and a handy "get me home" button.

VIBER

Free; also on Android, Chrome, Windows 8, Windows Phone

Not just another social network, Viber is a communications hub that lets you stay in touch via instant messages and voice and video calls – as well as sharing photos and videos.

Windows 8

PLEX

£3.49; also on Android, Chrome, iOS, Windows Phone

Most apps in the Windows Store are free, but this one really is worth the money. Plex offers a slick way to stream your personal media from any device to your Windows 8 machine.

That doesn't just mean within your home, either. If you have a video stored at home on your domestic NAS drive – but are away on business somewhere – you can use Plex to stream the content to your Windows 8 machine over the internet. Similarly, if you have content stored on your Windows 8 PC, Plex lets you stream it back to your smartphone, tablet or smart TV. It even works with Google's Chromecast, as well as Xbox and PlayStation consoles.



NEWS REPUBLIC

Free; also on Android, iOS, Windows Phone

News Republic is a slick news app that aggregates content from pretty much every news site on the web – from Cosmopolitan to Al Jazeera. So whether you're interested in sport, politics or the latest recipes, there's always fresh content to enjoy.

Of course, news-aggregating apps are ten a penny, but there are two things that set News Republic apart. First, it's beautiful to look at and easy to navigate – an important achievement when you're pulling together content from dozens of different sources. Second, it's intelligent: as you use the software, it learns what sort of news interests you and highlights suggested content.



TRELLO

Free; also on Android, iOS

If you need to organise a project of any size, Trello is perfect. It uses a card-based system to organise and group your tasks (based on a "kanban board" model). One thing that makes Trello stand out is its integration with other platforms: the software is available on Android and iOS, and there's an excellent web interface too, so you can get organised from anywhere with an internet connection.

What's more, Trello is great for team working. You can assign users to cards, mark deadlines, add comments and checklists and even set up automatic notifications with the Slack instant-messaging service, making it ideal for the office as well as your personal projects.

FILES&FOLDERS LITE

Free

The Windows Explorer wasn't designed for touch, so copying files and folders around on a tablet isn't exactly easy. Files&Folders Lite makes it simple, with big finger-friendly icons and controls for finding, organising and launching your local files. There's integration with OneDrive and Dropbox, too, so even cloud files are easy to manage.

own photos. You can even send your creations to CanvasPop to have them professionally printed and framed.

KHAN ACADEMY

Free; also on Android, iOS

Khan Academy is one of the biggest online learning centres, and its official Windows 8 app gives you direct access to a library of more than 6,000 educational videos. You can learn about a huge range of topics, from maths and computer programming to the basics of music, economics and history. It's like your own personal Open University.

TCATCHUP

Free; also on Android, iOS, Windows Phone

Despite the name, this isn't an app that lets you watch "catch-up TV"; if you want that you'll have to go to the respective channel's websites. Rather, it lets you watch a huge range of live TV over the internet, including all the major terrestrial channels, plus a selection of sports, news and music channels.

TUNEIN RADIO

Free; also on Android, iOS, Windows Phone

The TuneIn Radio app brings more than 60,000 different radio stations and two million on-demand programs to your Windows 8 desktop. Music, sports, talk and news are all represented: it can be tricky to find your way around at first, but once you crack the search feature, a world of audio entertainment is at your fingertips.

ONENOTE

Free; also on Android, iOS

Microsoft is still working on a truly touch-friendly version of Office, but the OneNote app is leading the way. It's a versatile note-taking app that lets you sync notes across your devices and share workbooks with friends and family – even if they're on a different platform. Best of all, it's free.

ESPN FC

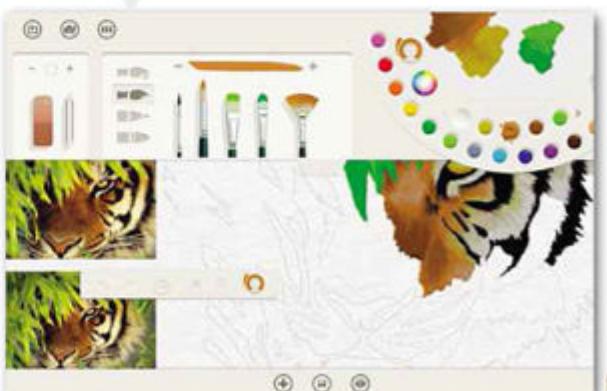
Free; also on Android, iOS, Windows Phone

The brand may be American, but ESPN FC brings football fans all the news, scores and statistics for your favourite British teams. You can specify which team you follow, then keep up with fixtures, results and rumours from the Premier League, Champions League, internationals and more. There are live alerts, Twitter integration and in-app video highlights too.

FRESH PAINT

Free; also on Windows Phone

One of Microsoft's original Windows 8 apps, Fresh Paint remains a great showcase for the creative potential of a Windows tablet. Paint with a fingertip, blend colours together, apply artistic effects and touch up your



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Windows Phone

ALLRECIPES

Free; also on Android, iOS, Windows 8

Allrecipes offers more than 20,000 recipes for culinary guidance and inspiration. The landing page offers a selection of Daily Recipes to keep things fresh, and there's also a "recipe spinner" that offers a random combination of meal type, main ingredient and cooking time, leading you to a list of suitable meals.

Each recipe comes with a full list of ingredients, an instruction video, nutritional information and reviews. Note, though, that measurements are given in American units: you may need to supplement the app with a conversion tool.



ANGRY BIRDS SEASONS

Free; also on Android, iOS

Angry Birds has been around forever, but the Seasons edition is regularly updated with new levels reflecting a current festival such as Christmas or Chinese New Year – so there's always a new challenge to enjoy.

TUBE MAP

Free; also on Android, iOS, Windows 8

Not everyone lives in London, but if you ever visit the capital, you'll find this route planner indispensable. It provides a complete map, going all the way to the outer zones, and also offers real-time service information and live departure boards.

UCBROWSER

Free

This Internet Explorer alternative supports many useful features, including tabbed browsing, incognito mode and a "Visit as PC" option, enabling you to view the full versions of mobile-aware websites.

FOODSPOTTING

Free; also on Android, iOS

Foodspotting reviews not only restaurants, but individual dishes; it's like TripAdvisor for meals. Perfect when you're looking for somewhere to eat in an area you don't know, or somewhere new in an area you do.

NEWS READER FOR BBC

Free

Windows Phone comes with MSN News, but for something more familiar, try this BBC news app. Since this isn't an official BBC app, you'll see some ads, but a premium ad-free version is also available for £1.29.

FACEBOOK & TWITTER

Free; also on Android, iOS, Windows 8

The two biggest social networks both offer official Windows Phone apps, and they're as fully featured as you could hope for, with support for images and video. There's also the standalone Messenger app, for chats with your Facebook friends.

VOICE RECORDER PRO+

Free

Despite the name, Voice Recorder Pro+ doesn't cost a penny, and the ads it does show are unobtrusive. It lets you record and save your phone conversations, and review them from within the built-in archive.

WINDOWS INSIDER

Free

If you're feeling bold, why not try out the Windows 10 Technical Preview for phones? You can roll back to Windows Phone 8.1, so if your handset is supported, you've little to lose by giving it a spin.

Chrome & Chrome OS

POLARR PHOTO EDITOR

Free

This photo-editing app offers simple, intuitive controls, including the ability to compare before-and-after images and watermark your photos.

POCKET

Free; also on Android, iOS

Save online items for later, to browse at your leisure. It's cross-platform, so you can save links on your phone, then view them on your desktop.

CARET

Free

This browser-based text editor offers a tabbed interface, syntax highlighting for numerous languages and a huge range of keyboard shortcuts. It works offline too.

KINDLE CLOUD READER

Free

Sync your reading across multiple devices, with bookmarks and other details saved in the cloud. You can also use the app to browse the Kindle Store and buy new titles.

UNTIL AM

Free

Until AM lets you take songs and sounds from SoundCloud or your hard drive and become a digital

mix master. Virtual turntables allow scratching and beat-matching, and with the effects panel you can add reverb, echo and delay.

STITCHERRADIO

Free; also on Android, iOS

Stream more than 20,000 shows and podcasts; share your favourite shows, and check out what your friends are listening to.

WORD/EXCEL/POWERPOINT ONLINE

Free

These free cloud-based tools let you open and edit Office files. You can only save to OneDrive, however – and as the title perhaps suggests, there's no offline mode.

TWEETDECK

Free

TweetDeck equips Twitter for power users. You can divide your feed into columns including mentions, interactions and more, and switch accounts with the touch of a button.

DOSBOX

Free

If you can handle a slightly clunky UI, DOSBox lets you play a raft of retro games, such as Monkey Island and Doom, right inside your browser.

WUNDERLIST

Free; also on Android, iOS, Windows 8, Windows Phone

This online to-do-list manager lets you create lists that can be edited by multiple people. You can "star" high-priority items, set reminders and sort tasks via criteria such as who added them or when they're due for completion. Use it to create a family shopping list, or a departmental list of work tasks. As well as integrating with Chrome, Wunderlist can be accessed on mobile devices and other browsers, so you can stay on top of your tasks no matter where you are.



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Android

Android is the world's most popular mobile platform, running on more than 80% of smartphones worldwide. It's supported by a vast ecosystem of apps: Google Play hosts nigh-on 1.5 million downloads, and that's before you consider the rival Amazon Appstore and other outlets.

It's true that Android isn't always the first choice for developers: statistics show that iPhone users are more willing to pay for downloads, so high-profile apps may be developed for iOS first and then ported to Android – or not at all. However, the more open nature of the system means there's a wider range of software available, and fierce price competition means great software can be had for free, or very cheaply.

CITYMAPPER – REAL TIME TRANSIT

Free; also on iOS

Google Maps is so 2014. Citymapper is the new way to get around – as long as you live in a city that's covered, which in the UK currently means either London or Manchester.

Within those cities, Citymapper provides extensive journey-planning tools, covering multiple forms of public transport – and it can additionally work out how much each transport option will cost. If your location has cycle-hire racks, Citymapper can even tell you how many bikes are available.

If you'd rather take a cab than hop on public transport, you can also get a quote for an Uber car and book directly through the app. It's frustrating that more cities aren't yet covered, but you can vote for yours to be the next one added. Here's looking forward to Citymapper's capabilities extending up and down the country.

Results			
Walk	124 cal	30 min	
Cycle	45 cal	~16 min	
Cab	£9+	~8 min	
SUGGESTED			
£2.30	23 min		
£1.50	27 min		
£2.30	25 min		
£3.80	26 min		
£2.30	26 min		
MORE: BUS ONLY			
£1.50	33 min		
£2.30	27 min		

THREES!

£1.31; also on iOS

Threes! is a simple puzzle game that challenges you to match up numbered tiles in pursuit of a high score. The game ends when you fill up the 4x4 grid – but the catch is, you can shift only an entire row or column of tiles at a time, so you can't simply move individual pieces to where you want them. You can also only match together two identical numbers, or the blue "1" and red "2" tiles to create white "3" tiles – and, with every movement, a new piece joins the board, so you need to keep matching and removing tiles as quickly as possible.

It sounds confusing, but it's one of those games where, once you start playing, you'll grasp it in moments. After which, thanks to the game's charm

and character, you'll quickly be sucked in and won't be able to put your phone down. Free clones exist, but they lack the polish, charm and character of Threes!.



SWIPE & SIGN YOUR NAME

THE WITCHER BATTLE ARENA

Free; also on iOS

The multiplayer online battle arena genre – MOBA to its friends – is exploding on the PC, and CD Projekt Red's The Witcher Battle Arena brings that competitive scene to Android. It's a fun, fast game that you can easily sink hours into without even trying. If you've been itching for League of Legends or Dota 2 on mobile, this is your fix.

DESERT GOLFING

£1.19; also on iOS

A calmer take on the "endless runner" gaming genre, Desert Golfing sees you flicking a golf ball into a never-ending series of procedurally generated, single-screen holes. The graphics aren't much to look at, but the simplicity of Desert Golfing's environment offers a zen-like experience that's relaxing as well as enjoyable.

experience and cut down the noise. It's invitation-only at the moment, but provides an elegant way to organise your emails and hide away the messages you're done with.

SNOWBALL

Free

Snowball aggregates all of your social networks into one place. Notifications are handled via a dropdown tray, and you can cycle between your networks with ease, leaving replies without having to close down the app you're currently using. It's simple, effective, and a great way to cut down the number of social apps you're juggling.



YO

Free; also on iOS

Once an utterly pointless app for annoying your friends, Yo has quietly become a powerful tool for curated push notifications. Subscribe to one of Yo's 150 channels – from BuzzFeed to Instagram and Twitter – and you'll receive a notification when one of your favourite authors makes a new post – with no need to install the corresponding apps.

ASTROFILE MANAGER

Free

Unlike iOS, Android lets you manage the files on your device. However, trying to keep track of all your downloaded files, sorting through your images and managing APKs can be a pain. Astro can manage all your files on cloud, internal and external storage. It can unzip, zip, share and launch files from a clean and clear front-end.

EVERNOTE

Free; also on iOS, Windows 8, Windows Phone

Evernote is the granddaddy of note-taking apps, and it ticks every box you could wish for: you can write notes, collect together web pages and photos, search your notes and present to others, all from within the app. And it runs on more or less everything, so you can access your content from wherever you happen to be.

GOOGLE OPINION REWARDS

Free

If you're addicted to apps, Google Opinion Rewards could help feed your habit. Install it, and you'll be invited to answer occasional short surveys – usually no more than three questions – in return for which virtual money is funded directly into your Google Wallet, to spend on more apps. You can opt out of surveys at any time, so what have you got to lose?

INBOX BY GMAIL

Free; also on iOS

The daily deluge of email can be hard to manage. With Inbox, Google seeks to refine the Gmail



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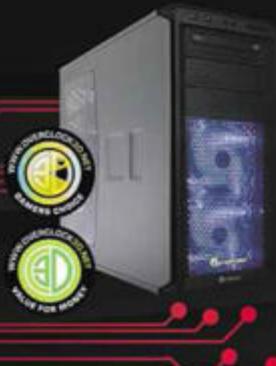


Minerva

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- 3 Years Warranty

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Android

CLEAN MASTER SPEED BOOSTER

Free

It's fun to download and try out apps, but you may soon find you're running out of space. Clean Master is the mop and bucket you need to scrub your device clean.

Its junk-file-cleaning feature scans your device and chuck out unwanted cache and long-forgotten downloads, and the app also contains features for helping your device run cooler, boosting available RAM and squeezing more power out of your device's CPU.

Since Clean Master allows you to tweak what it does to suit your preferences, it's perfect for anyone wanting to eke out more space and performance from their device – and who doesn't want that?



PUSHBULLET

Free; also on iOS

Some things work better on a bigger screen – or a physical keyboard. Pushbullet lets you push photos, screenshots, web links and even notifications across to your PC via a browser plugin. It isn't limited to your own devices either: you can also push content to other Pushbullet users you know, easily sharing video, images and documents for editing or collaborating.

Nor is Pushbullet a one-way process: if you decide to push notifications to your PC, not only can you read text messages on your desktop, you can reply from within the app too. You can also use Pushbullet like an RSS feed, having outlets push news to your feed or into your device's notification centre. Once you get started with Pushbullet, you'll find you barely need to pick up your phone at all.

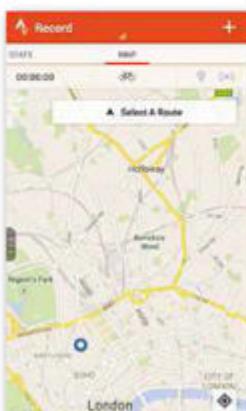
STRAVA RUNNING AND CYCLING GPS

Free; also on iOS

If you run or cycle, then Strava is a great way to keep track of your performance. Using your phone's GPS receiver, Strava can record how quickly you're moving and the route you're taking.

That may not sound revolutionary, but what makes Strava better than other sports apps is how it pushes you to do better, and lets you compete with strangers too. Strava can break your journey up into segments and square you off against others who have covered the same route, filling your times into a leader board.

For real fitness addicts, there's also a premium version for £4 per month, which gives you more detailed stats.



ESSENTIALS

OPERA MAX

Free

Unless you're one of the lucky few with an unlimited data plan, conserving your mobile data usage is a constant concern. Opera Max slashes your data consumption when you're online, by compressing audio, video and image files before you download them. It's an effortless way to make your megabytes go further.

POCKET

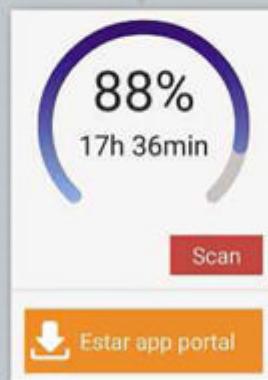
Free; also on Chrome, iOS

Seen an article online that you'd love to read but just don't have time? Pocket is the solution. This clever app allows you to save articles and videos for later viewing, on the same device or a different one. You don't even need an internet connection, as it all works offline, so it's perfect for flights or long train journeys.

ESTAR ENERGY SAVER

Free

Battery life is the bugbear of every mobile device. EStar Energy Saver helps you conserve battery by informing you of apps that are churning away in the background. It tracks how much power each one consumes when in standby, and suggests alternative power-friendly apps you could use instead.



AVAST FREE MOBILE SECURITY

Free

Mobile malware is a fact of life, so it pays to be protected. Avast's antivirus app for Android scans all downloads and installations for malicious software and trojans, and protects you while you browse the web. Best of all, it's free – so you can't afford not to install it.

GOOGLE AUTHENTICATOR

Free; also on iOS

Google Authenticator safeguards your online accounts through two-step authentication. Once you've registered, whenever you access a service such as Dropbox, LastPass or PayPal, you'll be prompted to use a time-sensitive code provided by the software. It isn't a sexy app, but it offers an extra layer of protection.



IFBYIFTTT

Free; also on iOS

Formerly known as IFTTT, If is a powerful automation tool that lets you create "recipes" that connect devices and services together, in ways that can make your life easier. For example, if you're a remote worker, you can use If to automatically email someone when you upload a file to Google Drive or Dropbox. Or, you might prefer to ping them on WhatsApp, or reach them on Slack.

And it isn't just about notifications. You might create a recipe to automatically add YouTube videos you mark as "watch later" directly into your Pocket account. Or perhaps you'd rather use it to tweet or publish a Facebook post at a set time, or when something specific happens.

Other supported services include eBay, Gmail, LinkedIn, Reddit, SoundCloud and WordPress, and you can create different types of trigger too: your recipes can be launched at the tap of a button, or triggered when you arrive at a specific location, as reported by your smartphone. In short, if you want to automate something, If will do it – for free.

99 BRICKS WIZARD ACADEMY

Free; also on iOS

Imagine playing Tetris with real-world physics. In WeirdBeard's 99 Bricks Wizard Academy that's exactly what you have to deal with. While there's a vague story thrown in around having to go to a wizard school to learn spells, the real joy of 99 Bricks is in the building.

Using tetrominoes that fall from the sky, you need to create a stable base and build a tower reaching up to the heavens. You'll have to be careful where you place bricks, since every one has weight and momentum to account for. Some bricks are made of ice, others of wood or stone. Icy bricks slide around and are a hazard to stable structures, whereas stone pieces lock everything around them in place.

If that weren't enough of a worry, the higher you build your tower, the stronger the wind becomes, meaning a stable footing is essential if you want to build your own Tower of Babel.



DUOLINGO

Free; also on iOS, Windows Phone

Learning a foreign language can seem daunting; many of us have memories from school of lengthy vocabulary lists and endless grammar tables. This is where Duo, the friendly green owl, swoops in to help.

Duolingo can teach you Spanish, German, French, Italian and various other languages, using clever gamification techniques to keep you engaged and motivated. Through a mixture of text, images and audio, you'll quickly pick up the basics. And since lessons are divided into short exercises, you never feel like you're spending too much time on improving your linguistic skills.

While the Duolingo approach keeps fuss and frustration to a minimum, the tougher lessons may still require concentration and perseverance – languages can be illogical and inconsistent, after all. But Duolingo helps you through with motivational reminders, virtual rewards and a point-scoring system that lets you compete with friends. Before you know it, you'll be fluent in your chosen language – and the best part about Duolingo is that it's completely free.



FENIX FOR TWITTER

£2.99

Twitter can be a vital news outlet, a business tool or an obsession. Unfortunately, the official Twitter app isn't built for much beyond light social usage. This is where Fenix comes in.

Sporting a slick and customisable interface, based on the Material Design template, Fenix streamlines your Twitter experience. Pictures and video are automatically expanded to fit the width of your phone; swiping left brings up all your mentions, and a second swipe takes you to your Activity feed. There's support for multiple accounts, multiple drafts, quick access to lists and saved searches, the ability to mute specified hashtags and much more.

SUPER HEXAGON

£1.99; also on iOS

The simplest ideas are often the most addictive, and that's certainly the case with this high-speed arcade game. Your goal is to survive as long as possible, by moving an arrow left and right around the screen, while avoiding approaching walls that shift and twist towards you.

AMAZON APPSTORE

Free

Google Play is packed with apps, but a little competition never hurt anybody, and Amazon's rival store is certainly worth a look. Its interface may be a bit of a mess, but it offers regular sales, giving you the chance to download apps at discount prices – and one paid-for app is given away absolutely free every day.

GOOGLE KEEP

Free; also on Chrome

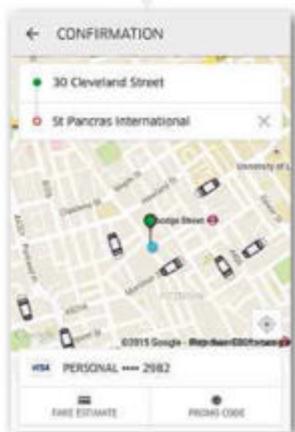
Google Keep is a great way to make quick notes and lists and share them with others. Voice notes and photos are supported too – and since it's part of Google's Drive suite of apps, it's accessible on practically any device, and links in with Google Now. It may not be bursting with features, but it's excellent for quick notes.

Dev Story is all about managing resources, delegating tasks, and shipping the most successful game you can.

UBER

Free; also on iOS, Windows Phone

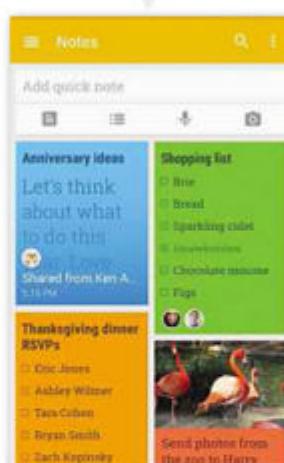
The upstart minicab service has attracted some controversy, but it's more dependable than standing out on the street and hoping a cab will pass by – and much cheaper too. Most ride requests are answered within minutes, and you can pay with Google Wallet, PayPal or a stored credit card – so you never need to worry about having cash on hand.



VLC

Free; also on iOS, Windows 8

VLC is famous for its ability to play more or less anything you throw at it, and the Android version doesn't disappoint. Its open-source development means transparent updates, and you always know what functionality your device supports. With Chromecast compatibility coming soon, it's an indispensable app.



GAME DEV STORY

£1.40; also on iOS

Presented in simplistic isometric 32-bit-style graphics, Game Dev Story is an unexpectedly brilliant little game. Tasking you with building a game-development studio from the ground up, Game

ZOMBIES, RUN!

£2.99; also on iOS

This clever app inspires you to get fit and run further by dropping you into an (imaginary) zombie apocalypse, where frenzied flesh-feeders are chasing you down. Keep your headphones in as you run and you'll be instructed where to run to next, while your phone's GPS determines if you're fleeing fast enough to survive the pursuing horde.



How notosshop changed the world

Adobe Photoshop has tweaked, brightened and enhanced our lives for 25 years. Adam Banks unmasks its many-layered reign

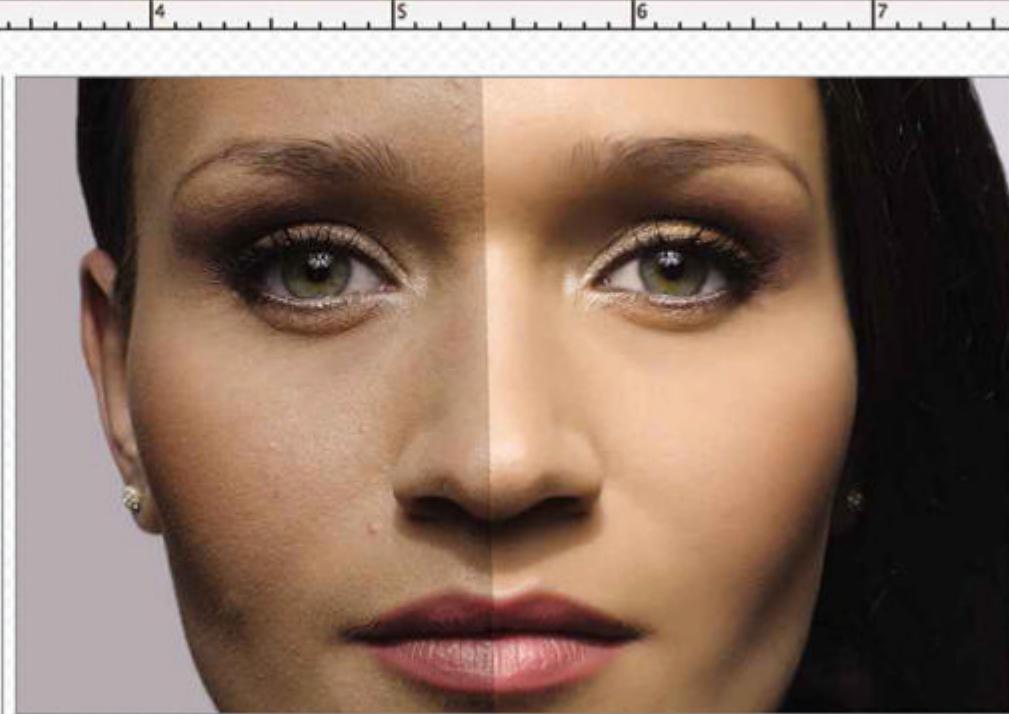
It's hard to believe there was no Photoshop before 1990. Its impact has since been magnified by the rise of digital photography and social media, and continues through an endless variety of rival products, but for a quarter of a century we've been living in the Photoshop age.

"Photoshop changed the ontology of the photograph," said Caroline Bassett, professor of media and communications at the University of Sussex. "It revolutionised our sense of the relationship of the photographic image to the reality it remade. Before Photoshop, it was easier to believe a photograph captured the truth. After, we knew it was constructed. I think it's the single most influential software package of the PC era."

This judgement would have surprised University of Michigan postgraduate Thomas Knoll when he began coding a graphics tool on his Mac Plus in 1987. "Painting" programs existed for the Mac and other early PCs, but Knoll's PhD was in computer vision. His brother John was working for George Lucas' visual-effects company, Industrial Light & Magic (ILM), and their father, Glenn, had a darkroom in their basement. Coming at bitmap editing from this fresh angle, they first sold their application bundled with newfangled scanners.

Before long, John had struck a deal with Adobe, which had just catapulted the Macintosh into the graphics business thanks to the Adobe LaserWriter printer. Priced at less than \$1,000 at launch – half the price of Letraset's ColorStudio software – Photoshop appealed to users who had latched on to the Mac as a way to get into cutting-edge creative work at a fraction of the cost. Previously, photo retouching had been performed by bureaux on six-figure workstations from companies such as Quantel and Scitex, charged at a going rate of £200 per hour. Now, in-house art staff could attempt it with Mac setups costing as little as £5,000 – and pros and amateurs alike could begin to invent new kinds of images.

Photographer and illustrator Ian McKinnell has used Photoshop since its days as a beta shared around ILM. "For the first year or two, I used it only for illustrating, but around that time there was a huge boom in photography, which paid far better, so I concentrated on that. There was so much dreadful retouching at first.



I often worked in the background, fixing other people's disasters."

Writer and photographer Martin Evening recalled how "more photographers started having a go at doing the work. It was a period of excitement for a few of us who were perhaps more nerdy and looked forward to seeing what could be done." Not all attitudes were so positive: "There were photographers who saw it as contaminating pure, 'real' photography; there were advertising clients who had contracts with the high-end retouching houses."

A touch too much?

As Photoshop spread through the industry, retouching quickly became faster, cheaper and more extensive in its capabilities, offering creative directors the opportunity to tweak every shot. The effect was much greater – and more controversial – than the sum of its toolset.

"In the fashion industry, there was always a clique of influential designers who strongly influenced the look of models," noted Evening. "Models had always tended to be undersized. Now, where a model or celebrity didn't meet that idealised look, they could be sculpted into it."

Interviewed by GQ in 2003, Kate Winslet asked why "women think in order to be adored they have to be thin". Her own picture on the cover was then Photoshopped to make her look thinner. "They've reduced the size of my legs by about a third," she later complained. In 2013, Lady Gaga

ABOVE Photoshop has transformed commercial photography from a product of lighting, make-up and camera settings (left) to a process of creating the perfected image required by the art director (right)

was so offended by the retouching of her *Glamour* cover that she used the magazine's own awards ceremony to attack "too perfect" images, assuring fans "I do not look like this when I wake up in the morning".

Nor, though, did any published image of Greta Garbo or Hatshepsut reflect their subjects' daily reality. Is Photoshop really to blame? In 2014, British *Vogue* editor Alexandra Shulman explained to Lily Allen on BBC Radio 2: "Nobody really wants to see a real person looking like a real person on the cover of *Vogue*."

As Photoshop spread, retouching quickly became faster, cheaper and more extensive

In 2012, Jennifer Lawrence told *Elle* that, by Hollywood standards, she was "a fat actress" – a perception that highlighted the unachievable body shapes favoured by the industry. But asked if her 2014 Dior campaign had been Photoshopped, she made no apologies: "I love Photoshop more than anything in the world. Of course it's Photoshop – people don't look like that." Her image was no more a representation of reality than the works of the cubists in Christian Dior's gallery a century earlier.

So, what's art and what's fakery? Margot Huysman, a picture researcher for the *Daily Mirror*, stresses the need to distinguish between types of content. "A big difference between news and commercial photos is that we wouldn't airbrush news. We have a duty to show reality unaltered." Even celebrity shots are treated with integrity. "As soon as you mess with someone's skin tone or the size of their hips, you're in trouble. I'd never dream of retouching a picture that way."

Photoshop, however, is adept at blurring lines. In 2005, *Newsweek* marked household-advice mogul Martha Stewart's comeback from an insider-trading scandal with a cover that depicted her perkily pushing backstage curtains. When rival *USA Today* questioned its authenticity, *Newsweek* executives admitted it was a "photo illustration" based on nothing more than a headshot.

Such images have their place within a tradition of metaphorical illustration. When *Newsweek* ran a cover story on Barack Obama's support for lesbian, gay, bisexual and transgender (LGBT) rights with a rainbow halo and the coverline "The first gay president", nobody thought it meant Obama was gay, or that he had been canonised.

"I don't think anyone would be fooled into thinking David Cameron's face Photoshopped onto a raver's body – I've actually done that! – is a real picture," said Huysman. But the Stewart montage risked confusion. Readers might think she had posed for the photo as self-promotion. More subtly, the claim that she'd emerged "thinner" gained support from the image. "If there were people who were misled, that's a problem," *Newsweek* assistant managing editor Lynn Staley conceded.

Virtually reality

Steve Caplin, author of the *How to Cheat in Photoshop* series of books, has wrestled with similar concerns. One example involved the *Sunday Telegraph*, which wanted him to illustrate Gordon Brown holding a meeting with business leaders: "When it was published, I thought, 'This looks too real.' I should have



put something in to make it more obviously an illustration."

More typically, Caplin's, seen

by millions in newspapers and magazines, offers a brand of hyperreal conceptual mashup that's inextricably linked with the emergence of image-editing software: the British Isles carved from bacon; Prince Charles as a trashy action figure. His work began in 1987 with a video camera and a capture card for the Mac Plus. With usable digital photography a decade away, video grabbing was the first practical source of images.

When Margaret Thatcher was ousted from Downing Street, a *Newsnight* interview with her successor, John Major, provided the

ABOVE L'Oréal claimed that Julia Roberts' perfect complexion was down to her "naturally healthy and glowing skin" – not its products

BETWEEN Photoshop has made it easy to manipulate images to illustrate a point; when doing so, it's good practice to make it obvious

basis for an early commission. "I got his head from lots of angles; the low resolution didn't matter," recalled Caplin, who was using Image Studio, the precursor to Corel Painter.

Photoshop's support for colour was a step forward, but of little use in an age of black-and-white newspapers and monitors. What converted Caplin was that it crashed less.

By 1994, Caplin had regular photomontage cartoon strips in *The Guardian* and *Punch*. The arrival of Photoshop 3 changed the game again with independent layers. "It's hard to express just how significant this was. You could do a montage and move things around afterwards. Previously, once you'd placed something in, you were stuck with it. It launched in the same week my son was born, and I remember thinking, 'I don't know which will have the bigger impact on my life.' I think it was Photoshop 3," he said, only half joking.

Caplin's work also extends to advertising, where Photoshop provides the tools to stretch the rules on how far images of a product, or its effects, can be synthetically improved. Here the limits are policed by the Advertising Standards Authority (ASA). In 2011, chief executive Guy Parker told the BBC that a degree of retouching was acceptable, but that an ad would be pulled if it was "likely to mislead". Defending one such ad, L'Oréal declined to reveal just how much Julia Roberts' face had been Photoshopped. Self-defeatingly, it attributed her flawless complexion to "naturally healthy and glowing skin".

Singer-songwriter Lorde in 2014 tweeted the unedited version of an image of herself that had been spread. "Remember flaws are okay," she said. No doubt she was thinking about a feedback loop any teenager can confirm: we see flawless faces and bodies pictured; we buy products that promise to help match them; we take selfies and edit them closer to the ideal; we post them on social media; the cycle repeats.

Consumer apps turn Photoshop techniques into one-click effects that subtract the experimental creativity and reinforce popular norms. So, are we Photoshopping real life?



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Policing the Photoshopppers

It's an issue that goes well beyond the cosmetic. Eliot Higgins has blogged since 2012 on the Syrian civil war and related conflicts under the pseudonym Brown Moses. Pioneering a "citizen journalist" approach to image analysis, he monitors YouTube and social media for photos and footage of weapons on the ground, piecing together conclusions that have been cited by human-rights groups, MPs and journalists. Spotting fake images, he says, is easier than you think – but that's not where the problems end.

"Most Photoshopped images from conflict zones tend to be fairly basic: flags or logos superimposed onto existing photos. A quick Google image search identifies the originals." A widely circulated satellite picture supposedly showing the downing of flight MH17 over Ukraine turned out to be a composite of several images – harder to match automatically, but no challenge for online communities familiar with the source material. "That made a number of 'experts' and news channels look extremely foolish," Higgins said.

ABOVE The man who started it all: Photoshop creator Thomas Knoll

Photoshop itself can be a powerful tool for revealing Photoshopping, using tonal adjustments to increase the visibility of cloning, changes in digital "noise" and other telltale signs. But Higgins said this is rarely necessary, since manipulated images are "not as common as people think... you're more likely to come across images from other events that have been reused." Again, reverse image search is the answer, but with "huge amounts of content [being posted], it will always be hard to get everyone checking every image they see".

Twenty-five years on, Photoshop is still the first choice of graphics professionals. Increasingly, its main competition comes from specialised tools; Adobe's own alternative, Lightroom, focuses on optimisation rather than manipulation. Although it's now seen as less of a sin to rely on Photoshop to clean up an image, Caplin said some purists who felt using Photoshop was cheating now accept Lightroom as "just replacing darkroom techniques".

Where more complex work is needed, it's shifting back towards being an outsourced job, as offshore services undercut the cost of the photographer's own time. The most skilled retouchers can still command high fees – but they're earned with the same tools anyone can install for £8.57 per month. "Photo manipulation has become so everyday we don't even remark on it," said Caroline Bassett. "Yet we remain attached to the idea that photographs should tell the truth – even if we know they don't." ●

Photoshop and race

With Photoshop's increasingly sophisticated tone controls, anything dark can be lightened and vice versa. That includes skin.

In 2008, L'Oréal was accused of "whitening" Beyoncé in pictures described by celebrity site TMZ as "severely Photoshopped". The company's response, that it was "categorically untrue" that it had altered her "features or skin tone", only highlighted the elusiveness of truth in photography. Every image we see has been altered – as we were reminded in 2015, when untouched images leaked of a naturally blemished Beyoncé in another L'Oréal campaign.

Writing for *The Guardian*, film critic Vanessa Walters noted that 2008's "racially ambiguous" styling was "a tactic Beyoncé appears to have used herself previously – perhaps to make her image

more commercial", reflecting the "legacy of slavery or colonisation".

A different perspective comes from Rachel Hills, author of *The Sex Myth*, who has worked as a picture editor. She questioned in a 2010 blog post whether so-called "whitewashing" was "racism or just bad Photoshop". Hill explained that artworkers would use Photoshop's Curves control to make the image brighter and create "that glowy, luminescent look" – but "on images of non-white people, it has the unfortunate effect of making them look whiter".

Darkening also raises questions of artistry versus other motivations. At the time of the OJ Simpson trial in 1994, *Time* and *Newsweek* used the same mugshot of the former sports star; on *Time*'s cover, he appeared much



ABOVE Oscar-nominated actor Gabourey Sidibe looked very different on a US *Elle* cover than in wire photos, right

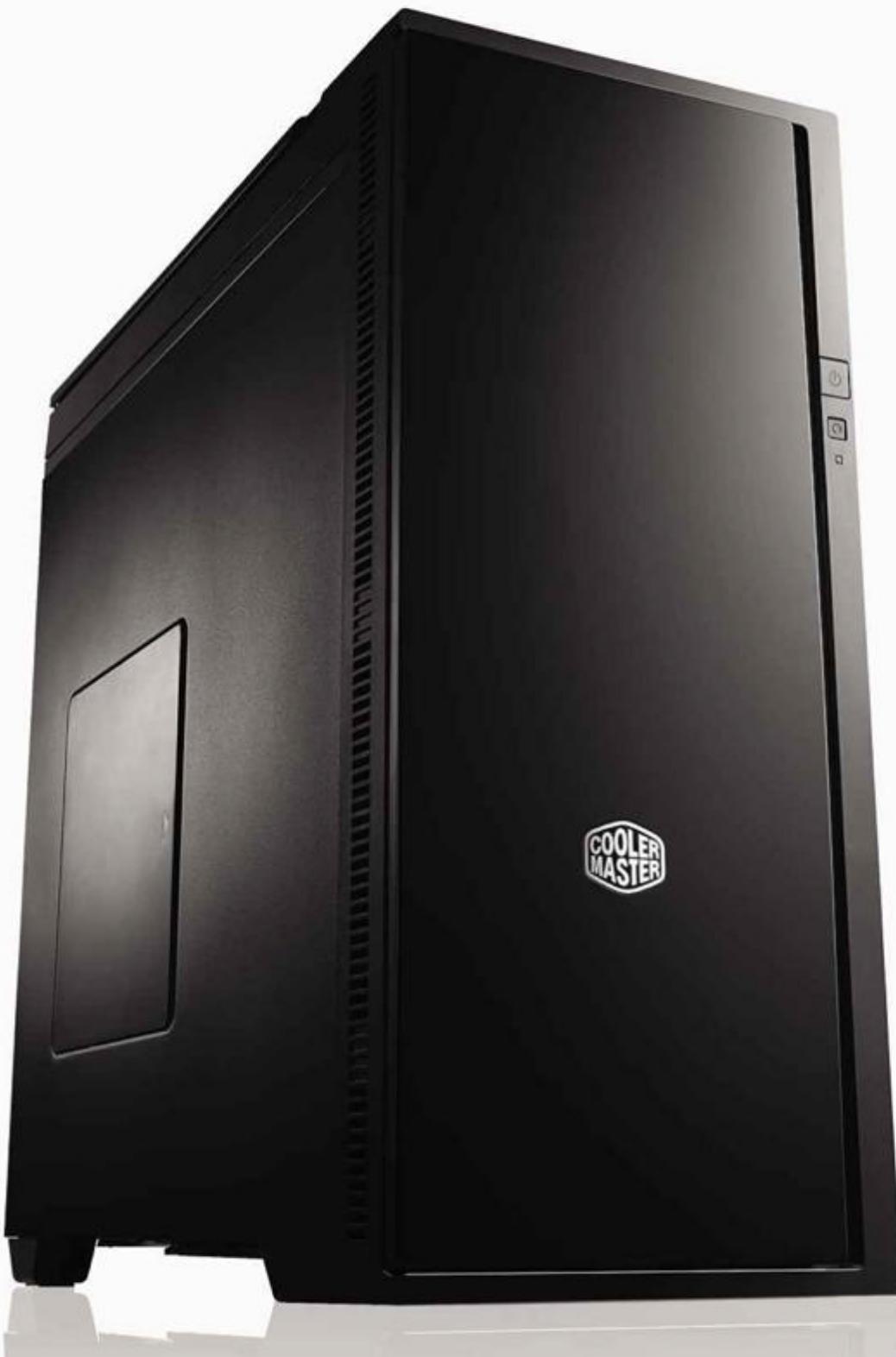
darker. Although the intention had been to cast him into shadow, the perceived play on the negative connotations of darkness was widely criticised.

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RISE OF THE MAKERS

Tinkerers unite! It's time to make the world a better place.
Gareth Halfacree explores the extraordinary and growing world
of the maker, and finds out how you can join in

The makers are coming. If you haven't yet heard of the maker movement, or got involved, now is the time to sit up and take notice: opportunities abound to join an existing maker community, or create your own around your interests. Even Intel is joining in, with a new Maker section on its website offering support and resources for those wanting to get involved.

You don't need any special skills. What appears to unite makers is a curiosity about how things work, a desire to improve upon what already exists and – in some cases – an urge to create something entirely new.

The defining feature of the maker movement is its adherence to the theory of constructivism: the argument put forward by psychologist and philosopher Jean Piaget that social play is an effective method for education, both in children and adults. The result is a community that values social interaction alongside creativity – the basis of a new technological revolution.

WHAT IS A MAKER?

So, what exactly makes a maker? "It's curiosity about the world around you," says Paul Beech, co-founder of Sheffield-based maker-centric electronics company Pimoroni. "Rather than saying, 'Oh, that's a nice thing, I'll use that,' it's, 'How does it work? What's inside it? I'll have a look, I'll make something myself.' You don't need to make anything to be a maker, because it's stuff that has been around for years; the whole making movement is just putting a name to it and gathering people around the same campfire."

"A maker is someone who will learn a process to achieve what they want to do," added fellow Pimoronian Jon Williamson. "I think generally it's physical things – not so much programming – but if you want to achieve or create something, and you're prepared to learn and do it yourself then, for me, that pretty much covers it."

Pimoroni is a great example of the transformative nature of the maker movement. Prior to the formation of the company, Jon was a programmer, while Paul earned a living in graphic and web design. That all changed in 2012, when the low-cost Raspberry Pi development board hit the market. "I won the competition [to design] the Raspberry Pi logo,"

BELOW Dominic Morrow says a hackspace can exist anywhere – it just needs like-minded people

Paul says, "which meant we were watching the project closely and got to be inside right at the start." Disappointed with the case designs on offer, Paul and Jon set out to design something better. "We thought it deserved to look fluffy."

There was a major hurdle to overcome before their "fluffy" Pibow case could become a reality, however: neither Paul nor Jon had any manufacturing experience or equipment – or the funds to buy it. That's where their introduction to the maker movement really took hold, thanks to a visit to a local hackspace.

ENTER THE HACKSPACE

Few scenes epitomise maker culture like a hackspace. Known under various names depending on their focus or affiliations, hackspace begin as a meeting of minds. "We started meeting in a pub about every third Wednesday," freelance maker Dominic Morrow recalls of the origins of Nottinghack, the hackspace he co-founded in 2010.

"We dreamed of a place where we could start collecting tools and leave projects stored. We struck a deal to rent a walk-in, bathroom-sized store cupboard. It opened out onto a shared room, and on our first night it rained so hard the electrics started to trip and fizz. It was awesome."

While the cupboard, situated "literally a Nerf dart-shot from Nottingham station", was Nottinghack's first physical facility, Dominic is clear that hackspace aren't defined by a building. "I've seen hackspace stall because they couldn't find a pub with Wi-Fi to meet in, or the landlord wouldn't let them use soldering irons. None of that matters, however. People willing to meet up regularly and get involved is key. If you have a big group of people, you've got a hackspace."

Regardless of its name or facilities, a hackspace tends to attract a certain type of

SIX STEPS TO STARTING A HACKSPACE

Nottinghack co-founder Dominic Morrow has this advice for anyone keen to start their own hackspace or collaboration environment:

1 Start with a community. If you've got a big group of people, you've got a hackspace.

2 Get a bank account. It can take a little while to sort one out, so start the process ASAP.

3 If you want a hackspace, you're going to have to do it yourself. Don't imagine you can get it started and others will do all the work.

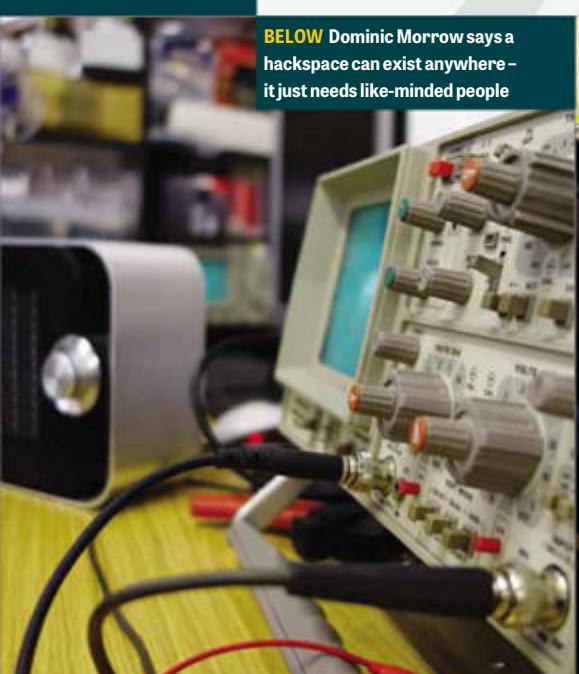
4 Think carefully about what you want. If you intend to run a hackspace to make a living, you're going to be disappointed.

5 Trust everyone until they give you a reason not to. All members must be equal; just have reasonable checks and balances.

6 Look outwards. Lots of people have done this before. Don't reinvent the wheel. Visit other spaces. Be part of the worldwide community. Be friendly.



BELOW Joining a hackspace gives you access to tools and equipment you might otherwise not be able to get

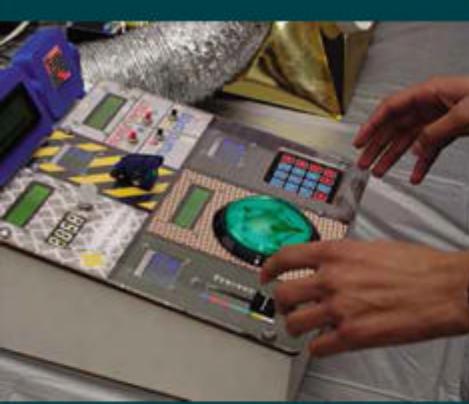




ABOVE The burgeoning Nottinghack group, founded in 2010, gathers for another session of collaborative tinkering



ABOVE Hackspace play host to equipment ranging from pillar drills and soldering stations to 3D printers and laser-cutters



ABOVE An enthusiast sets to work at the York hackspace SpaceHack, founded by Bob Stone

person. "Something you see in here that you don't see in engineering circles as much is people who really aren't afraid to fail," John Cole, founder of educational robotics firm Dexter Industries, explains with a chuckle. "They'll try anything, and maybe that's central to the whole ethos: there are a lot of failures, but that's because people aren't afraid to try. They don't know the limitations of what can be done, so they're not afraid to try something new, out there and interesting."

"I think the culture around [hackspace] is pretty accepting of people who don't know anything," adds John's co-worker Taryn Sullivan, who had no electronics or engineering background before joining Dexter Industries. "They're coming to this space at this time in their day and it's to contribute. I think it's a unique thing about this community that fosters a lot of great education and acceptance of anyone. I mean, of course I was a little bit nervous when I went to the first one. I was like, 'I know it's going to be all guys there' – and it was, but everyone was super-nice."

Hackspace are even appearing within more traditional educational establishments. Chris Leach of Winchester House School has recently been working to set up a collaborative hackspace within the school grounds, dubbed TinkerShed. "We have a small band of Year Six pupils acting as 'consultants' on the project," he explains, "so we know what they would like to achieve in the Shed. We've been lucky that our PTA has funded some of the initial renovation work, and we hope that by using it as a marketing tool for the school we'll get more budget next academic year to equip it further."

When a hackspace such as Nottinghack makes the shift from a meeting of minds to a physical workshop, it typically comes with a selection of tools. The march of technology has brought mechanised manufacturing down from giant, multibillion-pound factories to a level that's affordable to a motivated group of hobbyists – and even to an individual with a bit

of disposable income and a desire to tinker. Hackspace often play host to equipment ranging from pillar drills and soldering stations to 3D printers and laser-cutters, and provide members with tool training.

For Pimoroni's co-founders, it was the latter that caught their attention. "There was no laser-cutter in Sheffield that we could get access to when this idea was first creeping around our heads. We popped over to the Fab Lab in Manchester," recalls Paul of his efforts to bring the layer-based acrylic Pibow case to market. "It was a little unapproachable, and getting time on the laser-cutter was hard, but then Access Space in Sheffield got a laser-cutter through some European funding. I was immediately knocking on its door. That's what kicked it off."

Pimoroni now has laser-cutters aplenty, housed in its dedicated industrial unit in the heart of Sheffield. That sudden growth from a couple of people with an idea and a hackspace membership to a company with its own industrial premises and manufacturing machines came from necessity.

"We did a few rounds of the local hackspace, made the case and then put it up for sale – and it went nova. When you have 4,000 orders, you have to start a company to fulfil the requests. Pimoroni happened because it needed to

happen, because we needed someone to own the laser-cutters, sign for the premises and so on."

Without the help of the local hackspace, however, the company might never have been founded at all. "If that hadn't been there, it would have been a very different story. It might have happened later, it

might not have happened at all, but having the tools there, and people who could show us how to use the tools, was instrumental."

The low barrier to entry, thanks to the ability to share equipment, was another piece of the puzzle. "There was a total cost of less than £50, including Perspex, to start cutting prototypes. That's money a lot of people can scrape together."

Not everyone who joins a hackspace will go on to found their own company, of course. Many members already have jobs and aren't looking for new ones, while others attend simply for assistance with personal projects or to share their own expertise in a particular area.

SHOW ME THE MAKING

Many of the outputs of maker culture are intangible: its focus on education and its collaborative working process mean that even failed projects can be of use, and makers frequently take portions of others' creations – usually, although not always, shared under permissive licences such as Creative Commons – as a base on which to build something new.

Other results, though, hit the mainstream. The Slice, a media player powered by the Raspberry Pi Compute Module and created by

Pimoroni in partnership with members of the Raspberry Pi Foundation and music producer Mo Volans, hit Kickstarter last year and raised almost £230,000 from more than 1,500 backers to fund production. Without the maker-centric Raspberry Pi, the Slice would likely never have existed, yet its appeal extends well beyond maker culture into the mainstream.

Some projects are more niche, reflecting the passions of their creators rather than any desire to bring something lucrative to market. "We were looking for a group project to build at the hackspace that we could use as our debut exhibit at the UK Maker Faire in Newcastle," explained Bob Stone of the York hackspace SpaceHack.

The device – powered by a central Raspberry Pi and BeagleBone Black boards in its four control modules – acts as a physical incarnation of Henry Smith's Spaceteam mobile game: players are given a control panel each, and must carry out various tasks within a certain timeframe or disaster befalls the ship. To complicate matters, the controls are randomised with each turn, instructions are different for each player and the directions on one player's control panel frequently refer to controls held by another player.

"It's usually the young kids who get the hang of it fastest, come back to play again and start getting good," laughs Bob. "The game's timers speed up each round you survive, and it quickly reaches a point where it's hard to even speak the game's technobabble instructions before it's already timing out. I think we were seeing some kids get to the fifth or sixth rounds before blowing up."

Organised by the community, there are regular national Maker Faires, plus regional Mini Maker Faire offshoots, at which makers can meet and share their creations. Visit makerfaireuk.com to find one near you.

Another product of the maker movement is the rise of companies that target makers, which are typically born from that culture. Many choose to give back to the community: Dexter Industries' most famous creation, a Raspberry Pi-powered robotics kit dubbed BrickPi, was funded via a Kickstarter campaign, but released to all under a permissive licence; US maker store Adafruit has a learning portal that shares tutorials and projects, most based on components and devices sold on its main website.

Sometimes the creations are insular. The Arduino project, founded in 2005 to teach students at the Interaction Design Institute Ivrea about microcontrollers, is the perfect example: it created a low-cost microcontroller development board with a low barrier to entry. Released under a permissive licence, Arduino boards and third-party variants power numerous maker projects, but are rarely used by those outside the community except in an educational setting.

MakerBot Industries sought similar success with a range of relatively low-cost 3D printers, but it attracted criticism in 2012 when it began closing its creations, keeping the design files and source code proprietary.

HOW TO GET INVOLVED

Hackspace and their various offshoots are popping up nationwide, from Access Space in Sheffield to various manufacturing-centric

Fab Labs throughout the nation; you've almost certainly got one near you. Many "official" hackspace choose to list themselves on the website of the UK Hackspace Foundation at hackspace.org.uk.

For those in locations without a hackspace, getting started is straightforward. "Anyone can set up and call themselves a hackspace and use the logo," Nottingham's Dominic said. "In the future, there may be guidelines outlining what is or isn't a hackspace, funding to get one started, tools to help people find each other if they're hoping to start, and links to useful information on starting one."

For now, Dominic has the following tongue-in-cheek advice: "Withdraw all your money in cash and then throw it out of your window. Find the heaviest things you own. Pick them up and carry them upstairs; a few days later, pick the same things up and carry them all downstairs. Repeat. Have a party, buy booze and cakes and invite all the people you know. Sit and wait for no-one to arrive. Hold the same party every week. Eventually people will arrive and criticise you for the type of cake you purchased and tell you what beer you ought to have bought them."

Pimoroni's Paul has simpler advice: "Start doing something. If you haven't got a hackspace, set one up. Hackspace aren't about laser-cutters and 3D printers," he insisted. "Those are a nice fringe benefit. But hackspace are about people and space. Start finding like-minded people, start talking to them; that's a community. You don't create a community, you just start doing stuff and it grows."

MAKING IN THE HOME

The steady march of technology has made tools and equipment that would previously have been the domain of multinational corporations affordable for the hobbyist. Here's some of the most popular maker hardware.

Arduino A low-cost microcontroller, the Arduino uses a library dubbed Wiring to make programming the brains of an embedded hardware project as easy as possible for beginners. arduino.cc



Raspberry Pi The darling of the microcomputer world, the not-for-profit Raspberry Pi Foundation has sold more than five million of its sub-£30 compact computers, mainly to schools, universities and hobbyists. raspberrypi.org



MakerBot Although the company has come under fire for taking inspiration from open-source projects such as RepRap, only to close its own designs, MakerBot 3D printers remain extremely popular. makerbot.com



Makey Makey A great way to get kids interested in electronics, Makey Makey turns anything from bananas to pencil marks into capacitive touch-sensing buttons for devices such as the Arduino or the Raspberry Pi. makeymakey.com



Flotilla Pimoroni's latest creation, fresh from an overwhelmingly successful Kickstarter campaign. Flotilla is a family of "smart" input and output boards that make building electronic projects as easy as plug and play. pimoroni.com



Intel has long been the dominant force in mainstream computing, but the company was caught on the hop by the maker movement. When the Raspberry Pi, powered by chips designed by its rival ARM, began selling in earnest, Intel responded by creating boards of its own: the MinnowBoard, the Galileo and, most recently, the tiny-yet-powerful Edison and the wearable-centric Curie.

Although some, such as Pimoroni's Paul Beech, dismiss Intel's creations as "frankenboards" made by combining unsuitable individual components, the company continues to show genuine interest

in the market. It has launched Intel Maker on its website to consolidate its efforts, offering a Learning Center web portal focused on teaching makers how to use its creations.

Intel is a minor player in the market compared to Arduino and Raspberry Pi, but with a market cap that dwarfs its rivals, it's a company to watch in the coming years.

INTEL'S MAKER-OVER



Reviews



The biggest, best, most exciting products in tech – tested, evaluated and reviewed

Dell XPS 13 (2015)

Dell's ultra-compact MacBook Pro rival gets (almost) everything right

SCORE ★★★★☆

PRICE £916 (£1,099 inc VAT) from dell.co.uk (pcpro.link/248dellxps)

For a long time now, if you've been after the very best in slim, light laptops – with zippy performance that doesn't deteriorate over time – you've had to turn to Apple. But the challenge from Windows machines is steadily growing, and Dell's latest laptop, the XPS 13, aims to pull ahead of Apple.

From a design perspective, Dell has got it nailed. The laptop's lid and base are finished in silky-smooth aluminium that feels stiff enough to survive a nuclear strike – or at the very least being sat on. The keyboard surround is clad in a soft-touch, carbon-fibre-effect plastic, and despite the bombproof build, the whole device weighs a mere 1.27kg. That's a smidge lighter than the MacBook Pro 13in with Retina display, and even the 13in MacBook Air.

It outdoes the Cupertino crew on practicality too, with two long rubber feet stretching across the underside of the chassis, giving it a grippy footing on a desk or your lap. There's also an LED battery-capacity indicator on the left edge, activated by pressing a button.

The keyboard is decent: it's backlit, and has a light yet positive action. The touchpad is accurate and, for those who prefer clicking to tapping, the integrated buttons work without fuss.





Screen quality

The real attraction of the XPS 13 is its so-called infinity touchscreen, which sees the bezel reduced to a mere 5mm to the sides and above the screen, producing a machine that, in terms of its overall size, feels more like an 11in laptop.

Indeed, its dimensions of 304 x 200 x 20.7mm are closer to those of a MacBook Air 11in (300 x 192 x 17mm) than its real rival, the MacBook Pro 13in; Dell has done sterling work in squeezing the screen into less space.

On first impressions, the IPS panel looks good. The Quad HD+ resolution of 3,200 x 1,800 means that content appears incredibly sharp. (As always, though, do bear in mind that legacy software that hasn't been optimised for high-DPI screens may be fiddly, with minuscule buttons and tiny text.)

The screen is also exceedingly bright, reaching up to 385cd/m², while the black level dips as low as 0.15 with the brightness settings pushed to maximum. Taken at face value, these numbers are extraordinary. However, the reality is somewhat less impressive: Dell employs aggressive dynamic contrast to brighten the display when the screen image is light, and to dim the backlight when the onscreen content is dark.

In fact, the XPS 13's panel delivers a contrast ratio of 1,076:1. That isn't necessarily what you'll see, though, as the dynamic contrast can't be disabled: essentially, you're stuck with a screen that brightens and darkens noticeably when the content changes, something that's annoyed

some customers in the US enough to return their laptops. As a result, it's impossible to use the Dell XPS 13 as a colour-critical photo editing tool, since you're never certain of your black point. And we were none too impressed with the consistency of the screen's backlight, either. On our sample, the panel was noticeably brighter in the top-left corner than elsewhere, and afflicted by visible light leakage in the bottom corners. For a machine costing this much, that simply isn't acceptable.

Performance and specs

It's a huge shame, since elsewhere the Dell XPS 13 is a capable ultraportable. Every model in the range employs Intel's latest 14nm Broadwell CPUs, from the entry-level £875 Core i5 model to the range-topping, £1,271 2.6GHz Core i7-5600U specification.

We were sent the slightly less expensive 2.4GHz Core i7-5500U unit for our testing, and it performed admirably, achieving an Overall score of 0.7 in the PC Pro Real World Benchmarks. That's a fraction slower than the Asus Zenbook UX303LA, which has the same CPU, but the difference is small enough to be academic. We're none too keen on the rather whiny fan, though, which kicks in with great gusto as soon as you push the processor hard.

Still, it's enough horsepower to run all but the most demanding creative applications, and the rest of the specification is up to the mark as well. There's 8GB of RAM and a 256GB Samsung PM851 M.2 SSD for storage, which is reasonably quick, gaining sequential read and write speeds of 514MB/sec and 231MB/sec in AS SSD. It isn't a patch on the MacBook Pro 13in's drive, however, which reached speeds of 723MB/sec and 616MB/sec for sequential reads and writes.

Elsewhere, Intel's integrated GPUs keep improving, so should you want to indulge in a little out-of-hours gaming, you'll find the Dell XPS 13's Intel HD Graphics 5500 more than capable. The XPS 13 achieved frame rates of 44fps, 27fps and 4.9fps in our Low (1,366 x 768), Medium (1,600 x 900) and High quality (1,920 x 1,080) Crysis tests – that's easily enough grunt for a little light gaming.

Battery life and connectivity

Where the new, super-efficient 14nm processor ought to make its presence fully felt is in battery life, but here we

+ Fabulous build quality and stunning attention to detail; a superbly designed piece of hardware

- The screen looks great, but is hamstrung by inconsistent backlighting and permanently on dynamic contrast

weren't blown away. It lasted 11hrs 16mins in our light-use test, only marginally better than the last-generation, Haswell-based MacBook Pro 13in with Retina display, and a long way behind the Asus Zenbook UX303LA, which kept on trucking for 13hrs 6mins. Still, for a laptop with this much power, anything over ten hours in this test is good.

Connectivity is disappointing, however, with only two USB 3 ports, a mini-DisplayPort out for video, an SD slot and a 3.5mm headset jack, plus no Ethernet port of any description. We suppose we shouldn't complain too much when

Apple's latest MacBook includes only one USB Type-C connector, but wireless support isn't all that impressive either, with 2x2 stream 802.11ac Wi-Fi and Bluetooth LE, but no 4G.

"The so-called 'infinity' touchscreen sees the bezel reduced to merely 5mm to the sides and above the screen"

RIGHT The keyboard is comfortable in use and the trackpad's integrated buttons work accurately



BELOW Dell has created a slim and light laptop to rival Apple's MacBook Pros



Verdict

To tell the story of Dell's XPS 13 is to relate a story of what might have been. There's no denying its stunning design: it's attractive, beautifully built and practical, and Dell has squeezed into this glamorous chassis a 13in laptop that's closer to most 11in portables in overall dimensions.

However, it's a laptop that's beset by little niggles, none more disappointing than the infinity display, which is meant to be the star of the show. If all you want is a fast Windows laptop with a bright screen, and colour accuracy isn't of prime importance, it's a fantastic piece of kit. But it isn't all that we were hoping for. **JONATHAN BRAY**

KEY SPECS:

- Dual-core 2.4GHz Intel Core i7-5500U
- 8GB DDR3 RAM • 256GB M.2 SSD • Intel HD Graphics 5500 • 3,200 x 1,800 IPS touchscreen • 2 x USB 3 • mini-DisplayPort
- SD slot • 802.11ac Wi-Fi • Bluetooth LE • Windows 8.1 64-bit • 1yr NBD warranty • 304 x 200 x 20.7mm (WDH) • 1.27kg (1.56kg with charger)

BATTERY: light use, 11hrs 16mins



REAL WORLD BENCHMARKS

3.4GHz Intel Core i7-2600K, 4GB DDR3 = 1

OVERALL 0.7

0 0.25 0.5 0.75 1 1.25 1.5 1.75

Apple MacBook Pro 13in with Retina display (2015)

Apple updates the MacBook Pro with new Intel chips and Force Touch trackpad: the best just got better

SCORE

PRICE £833 (£999 inc VAT) from apple.com/uk (pcpro.link/248mac)

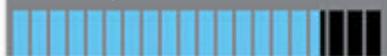
The new 13in MacBook Pro looks identical to last year's model, down to the last millimetre. But looks can be deceiving: this updated laptop quietly debuts Apple's brand-new Force Touch trackpad.

It's a simple idea. Press gently and the pad responds with a solid click, the touchpad moving just the tiniest bit under your finger. Apply a little more pressure, and embedded electromagnets provide the feel of a weightier "Force Click". It's perfectly convincing, but it's generated via haptic feedback rather than physical movement, which means it's possible to adjust the pressure required between light, medium and firm.

This may not sound hi-tech, but it adds a new dimension to desktop interaction. Force-Click on a file and a preview springs up; try it on a link in Safari, and the linked page appears in a preview window. Force-Clicking on selected text brings up relevant Dictionary,



BATTERY: light use, 16hrs 42mins



REAL WORLD BENCHMARKS

3.4GHz Intel Core i7-2600K, 4GB DDR3 = 1



Thesaurus and Wikipedia entries. Once third-party app developers get in on the act, we can see it becoming indispensable.

Internally, it's a case of evolution rather than revolution, with Intel's 14nm Broadwell processors replacing last generation's Haswell CPUs. We tested the entry-level £999 model, which comes with a 2.7GHz Intel Core i5-5257U, 8GB of RAM and a 128GB PCI Express SSD. The memory is soldered, and the SSD is a proprietary one, so don't plan to upgrade it yourself, but you can move up to a 2.9GHz Core i5 for £80, or a 3.1GHz Core i7 for £250; upping the storage to 256GB adds a further £200 to the cost. For the fully stacked Core i7 model with 16GB of RAM and a 1TB SSD, you'll need to find £2,129.

As we've seen before, Broadwell doesn't bring a real performance bump over the Haswell generation: in our Real World Benchmarks and games tests, performance was nigh-on identical. Gamers should definitely look elsewhere – they're better served by Windows laptops such as the Gigabyte P34G.

The new model does feel more responsive than before, however, probably thanks to the PCI Express SSD. In the AS SSD benchmark, our 128GB drive soared past last year's model, with sequential read and write speeds of 1,299MB/sec and 625MB/sec.

And when it comes to battery life, the 2015 MacBook Pro really raises the stakes. In our light-use test it lasted 16hrs 42mins – more than five hours longer than the previous model.

Beyond that, the MacBook Pro is much the same as ever – and that's no bad thing. The display remains a vision of beauty, its 2,560 x 1,600 resolution providing pristine image



ABOVE The 2015 MacBook satisfies with both the new features and the essentials



"When it comes to battery life, the 2015 MacBook Pro raises the stakes – it lasted more than five hours longer than the previous model!"

quality across every one of its 13.3 inches. Brightness tops out at 400cd/m², contrast hits an impressive 994:1, and the panel covers 97.7% of the sRGB colour gamut. Colour accuracy is superb: an average Delta E of 1.61 and a maximum of 4.43 confirm this as a laptop that's ready for colour-critical photo- and video-editing duties. Our only tiny niggle is that the darkest greys disappear a little too readily into black – we'd be tempted to perform a full calibration before starting a professional project.

Elsewhere, essentials such as the backlit keyboard continue to satisfy: the keys are well spaced, with a lovely crisp bounce. The speakers and webcam are surprisingly capable by

laptop standards. And with twin Thunderbolt 2 ports, two USB 3 ports, HDMI output and an SD slot, there's plenty of scope for expansion. The only small annoyance is the way SD cards still stick out of the reader slot by 15mm.

In all, the new 13in MacBook Pro is an even more attractive proposition than before. It's light, powerful and obscenely long-lasting. There might not be quite enough new here to justify upgrading from last year's model, but for everyone else the new 13in MacBook Pro with Retina display is as good as it gets. **SASHA MULLER**

Stupendous battery life, a fabulous screen and the Force Touch trackpad works really well

Not enough of an upgrade for owners of last year's generation to justify

SPECIFICATIONS

2.7GHz Intel Core i5-5257U • 8GB RAM • 128GB SSD • Intel Iris Graphics 6100 • 13.3in 2,560x1,600 display • dual-band 802.11ac • Bluetooth 4 • 2 x USB 3 • 2 x Thunderbolt 2 • HDMI • SD card reader • OSX Yosemite • 314 x 219 x 18mm (WDH) • 1.56kg (1.82kg)

Dell Venue 8 7840

Not only is Dell's Android tablet a stunner, it's packed with interesting technology too

SCORE ★★★★☆

PRICE £260 (£312 inc VAT) from amazon.co.uk (pcpro.link/248venue)

Android tablets can seem like much of a muchness, but the 8.4in Dell Venue 8 7840 is a refreshingly off-trend effort. It ticks the "super-thin" box, then upsets the apple cart with a barely-there bezel and dark metallic-grey finish.

It's an expensive-looking device, and by Dell's measurements, it's the thinnest tablet on the market: measuring 6mm at its thickest point, it undercuts the iPad Air 2 by 0.1mm. Into that slim frame, the Venue 8 7840 packs a quad-core Intel Atom Z3580 SoC and 2GB of RAM, providing a respectable level of performance. The SunSpider browser benchmark completed in 614ms – not up there with the likes of the Samsung Galaxy Tab S 8.4, but still pretty quick.

Similarly, GFXBench's demanding T-Rex HD (onscreen) benchmark achieved an average frame rate of 20fps: hardly record-setting, but far from slow. A spin at the wheel of Asphalt 8 produced frame rates that were fine for entertaining gaming, if not the smoothest driving experience.

Our only gripe with the internals is the limited onboard storage. The Venue 8 is sold as a 16GB device, but comes with less than 9GB available for your downloads and media. Still, a small, paperclip-ejected tray lets you add a microSD card of up to 512GB.

One thing that sets the Venue 8 7840 visually apart from other tablets is the edging around the 16:10 display: this is super-thin at the top and sides, but there's a much bigger bezel at the bottom. This houses a pair of stereo speakers – a clever design that makes it hard to accidentally muffle the speakers with your hands while holding the tablet.

There's also a 2-megapixel, front-facing camera for video calls. Here the positioning doesn't work so well: it's easy to cover the camera with your hand when holding the Venue 8.

The off-centre design throws up another problem too. If you

need to type out an email or a note, you might want to turn the tablet on its side to take advantage of the full-width keyboard. But with the Venue 8 in this configuration, your thumb has to stretch uncomfortably across the wide bezel.

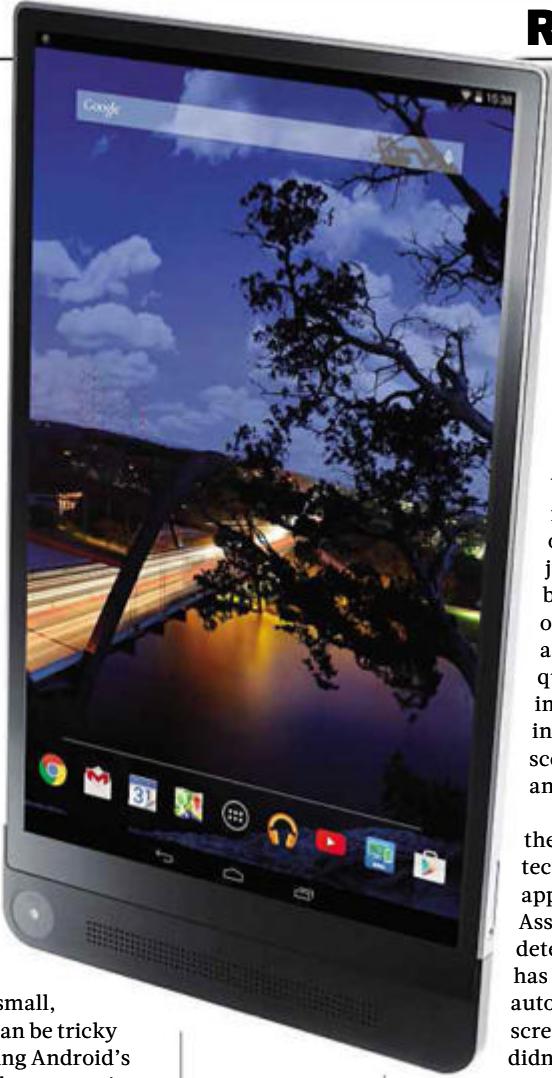
If anything makes up for that, it's the quality of the screen. It's an OLED panel, which is unusual for a tablet, with a top-drawer resolution of 1,600 x 2,560 pixels providing an extremely high display density of 359ppi. With default settings, this means that standard-sized text actually looks rather small, and links in Chrome can be tricky to hit accurately; setting Android's default text size to its largest setting produced a far more pleasant reading experience.

OLED panels are never as bright as their IPS counterparts; a measured peak brightness of 288cd/m² isn't top of the charts, and that's no surprise. However, OLED's effectively infinite contrast ratio means the Venue 8's display is still a joy to gaze upon: colours appear rich and vibrant, and deep blacks result in videos and photos looking fabulous.

Taking photos with the Venue 8 is interesting. The front camera is straightforward, but the 8-megapixel rear camera includes Intel's RealSense Snapshot technology. This means that, in addition to the main camera mounted centrally at the bottom of the device, there are two cameras that make it possible to capture depth information.

One practical benefit of this is that it allows you to measure the distances between two points in an image. This works reasonably well: we tried measuring the screen diagonal on a 13.3in laptop, and the tablet told us it was 1ft 1in. You might not use this capability every day, but we can see it being

BATTERY: video playback, 13hrs 46mins



ABOVE The Venue 8 7840's superb OLED panel offers up vibrant photos and videos

handy as a rough-and-ready measuring tool.

When it came to more creative effects, however, we didn't find RealSense worked particularly well. After taking a photo, you can choose to alter the focal point or blur the background – but we found these effects often threw up ugly, jagged artefacts between the in- and out-of-focus areas of an image. Overall image quality wasn't terribly impressive either: both indoor and outdoor scenes appeared grainy and over-compressed.

The camera isn't the only Intel-branded technology to make an appearance. The Sensing Assist feature attempts to detect when the Venue 8 has been picked up and automatically wake the screen. We found this didn't work perfectly:

sometimes it failed to wake up when picked up, and sometimes it woke up at the wrong time. Generally, though, the Venue 8 did an impressive job of distinguishing between being picked up and being merely jostled. It isn't a huge selling point, but it gives the Venue 8 a pleasing little zap of

pizzazz each time you lift it off the desk.

Overall, the Venue 8 7840 is a likeable tablet, with a character of its own and some distinctive technologies under the hood. Clearly,

these aren't exactly game-changing: we doubt you'll be needing to measure distances within photos every day. The form factor may not suit everyone either, especially those with small hands. However, the core specifications, performance and screen – not to mention that classy, ultra-thin design – make this a tablet that's well worth investigating. **DAVE STEVENSON**

SPECIFICATIONS

Quad-core 2.33GHz (burst) Intel Atom Z3580 SoC • 2GB RAM • 16GB storage • microSD slot • 8.4in 1,600 x 2,560 OLED display • 8MP RealSense Snapshot rear camera • 2MP front camera • 802.11ac Wi-Fi • Android 4.4.4 (KitKat) • 1yr C&R warranty • 124 x 6 x 216mm (WDH) • 305g



Samsung Galaxy S6

Samsung finally nails it – the S6 is the most fully featured, powerful and attractive smartphone around

SCORE ★★★★★

PRICE £500 (£600 inc VAT); from free on a £35/mth, 24mth contract from omio.com

For many years now, Samsung's smartphones have been among the best, packing in the latest technology. One thing has held them back from true greatness, however, and that's design. With the Galaxy S6, the company has finally broken free of those shackles; the Samsung Galaxy S6 is, unequivocally, the best smartphone you can buy.

It's a stunner, framed in cool-to-the-touch aluminium; the Galaxy S6 is a beautiful phone to behold. It's clad in Gorilla Glass 4 front and back, and the way it gleams and glistens in the light is quite entrancing. The S6 is available in White Pearl, Gold Platinum and Blue Topaz, but we think it looks best in Black Sapphire, which is effectively a very dark blue.

As you'd expect from a modern smartphone, the S6 is extremely slim (6.8mm) and light (138g), and it feels compact in the hand, surprisingly so considering the 5.1in display. In our view, it's the perfect compromise between screen size and one-handed comfort, and it combines that with impressive build quality and attention to detail. Even the volume, power and home buttons feel like they've been upgraded: everything about this phone feels perfectly on point.

There are some downsides. The replaceable battery and microSD slot for storage expansion have been consigned to the bin. There's no water or dust resistance, and the glass rear of the phone picks up fingerprints at an alarming rate.

A stunning display

The S6 makes no such compromises with its display, though. Its 5.1in, 1,440 x 2,560 Super AMOLED panel delivers a phenomenal pixel density of 576ppi, and colour accuracy, brightness and contrast are superb.

In manual brightness mode, the screen ramps up to only 347cd/m², which is what we'd expect of an AMOLED display; pop it into auto-brightness mode, however, and it will soar to 560cd/m² to aid readability on bright, sunny days.



Turn down the brightness to minimum and white tones will dim to 1.92cd/m², which means the S6 won't blind you when you're using it in the dark. Contrast is perfect, which helps movies, TV programmes and photos really pop out of the screen.

What's most impressive about the screen, though, is its outstanding colour reproduction. In Basic (sRGB) mode it reproduces 98.5% of the sRGB colour gamut. It's colour-accurate, too, with an average Delta E of 1.47 and a maximum of 4.13 – scores we more often see on professional monitors. It's a truly stunning display.

Performance and specification

In terms of the performance-critical elements, Samsung pushes the boat out. Both the S6 and the S6 edge employ its octa-core Exynos 7420 SoC, which comprises twin quad-core CPUs (one running at 2.1GHz and the other at 1.5GHz) and a Mali-T760 GPU. There's 3GB of RAM, and storage runs to 32GB, 64GB or 128GB on the S6 and 64GB or 128GB on the S6 edge.

It's a line-up that makes for a very snappy

ABOVE The Gorilla Glass 4 finish – both front and back – gives the S6 a quality look and feel



ABOVE The S6's camera adds a wider aperture and optical image stabilisation

phone. Nothing we threw at it caused it to slow down significantly, from hefty web pages to browsing Google Maps – it was all supremely responsive, and even under load it didn't become too warm.

It outperforms most of its rivals in the benchmarks, too. Single- and multi-core results of 1,485 and 5,282 in Geekbench 3 are overall the best we've seen, falling behind the iPhone 6 and iPhone 6 Plus only by a touch in the single-core test, and trouncing them in the multi-core test.

It completed the SunSpider benchmark in an equally quick 355ms, again matching the iPhones; it's only in the GFXBench T-Rex HD onscreen gaming benchmark that it lags behind Apple's flagships, with an average frame rate of 33fps, which is mainly due to the higher-resolution display.

The Samsung Galaxy S6 is clearly a fast phone, but the Exynos 7420 is about more than speed. Just like Intel's new Broadwell generation of CPUs, it's a 14nm part, which should mean greater efficiency and better battery life. And with Samsung reducing the size of the



battery by 200mAh to 2,600mAh, it needs to deliver.

In testing it did just that. Playing a 720p video in flight mode with the screen brightness set to 120cd/m², we saw capacity fall at a rate of 6% per hour: a figure bested only by the iPhone 6 Plus. With the screen off, the S6 used up its battery capacity at 2.8% per hour – less impressive, but this still places it among the most frugal smartphones we've tested.

As if to compensate for the lack of microSD expansion, the S6 also comes with a new type of flash storage. Dubbed UFS (universal flash storage) 2, it combines characteristics of the eMMC used in most smartphones and tablets and the SSDs deployed in laptops.

It's certainly quick. Testing with the AndroBench app, we saw sequential read and write speeds of 319MB/sec and 142MB/sec – very nippy for a smartphone.

Other specifications are a touch more humdrum, but this isn't necessarily a bad thing, with 802.11ac Wi-Fi, Cat6 4G, NFC and Bluetooth 4 all present and correct. The phone also retains most of the core features of the Galaxy S5, with a barometer, a heart-rate sensor on the rear, and ANT+ compatibility.

What's new is support for both the WPC Qi and PMA wireless-charging standards and a fingerprint sensor that you no longer need to swipe your finger over; it's now possible to simply rest a digit on the home button to unlock the phone.

■ Camera, audio and call quality

The S6's camera isn't a radical upgrade. It has the same 16-megapixel resolution as the S5, and retains that super-quick phase-detect autofocus, but adds a wider aperture and optical image stabilisation (OIS).

These may sound like small changes, but in practice they make a dramatic difference to the Galaxy S6's photo- and video-capture capabilities. In all but the darkest of environments, the S6 is capable of capturing stunning images and smooth, stable video. Noise is still visible when capturing objects in low light, but even then you'll get usable results in most circumstances.



ABOVE At only 6.8mm thick, excluding the camera lens, the S6 is extremely slim

The camera also boasts some new features: you can launch it by double-clicking the home button; it's possible to tap the heart-rate sensor to snap a selfie; and video capture now benefits from object-tracking autofocus. The latter worked well in testing, but it can't be used with optical image stabilisation (OIS) simultaneously.

Audio is almost as impressive, both in-call and from the single speaker on the phone's bottom edge. The earpiece speaker goes superbly loud and doesn't distort at maximum volume, and speaker output is good, matching the HTC One M9 for volume, if not body. The microphone is decent, too, picking up vocals at close and long range with admirable clarity.

■ Simpler software

Like any high-end smartphone worth its salt, the Samsung Galaxy S6 runs Android 5 Lollipop, and as usual it's heavily modified, courtesy of Samsung's TouchWiz software.

This year, however, we see a significant change in direction by Samsung, with the company cutting out the clutter and slimming down what had become a hugely bloated UI. We're still not too keen on the Briefing newsfeed that appears by default to the left of the main homescreen, but it's gratifying to see that Samsung no longer litters the rest of Android's homescreens with a hotchpotch of large, ugly widgets.

■ Verdict

The Samsung Galaxy S6 edge (see right) catches the eye with its unusual looks, but we suspect it's the standard, slightly more affordable S6 that will attract most consumers. The design is superb; the build is excellent; it's fast, it's slick, and its camera captures great pictures and video.

"The Samsung S6 is clearly a fast phone, but the Exynos 7420 also contributes to greater efficiency and better battery life"

You could criticise it for lacking a microSD slot and removable battery, and we're sure those omissions will put off many people. But in every other respect, the Galaxy S6 is a superb smartphone, easily outshining the HTC One M9. If only the best will do, look no further: the Samsung Galaxy S6 is the best smartphone on the market. **JONATHAN BRAY**

SPECIFICATIONS

- Octa-core 2.1GHz/1.5GHz ARM Exynos 7420 SoC • ARM Mali-T760 GPU • 3GB RAM • 32/64/128GB storage • 5.1in 1,440 x 2,560 Super AMOLED display • 4G (Cat6) • Bluetooth 4 • NFC • dual-band 802.11ac Wi-Fi • 16MP/5MP rear/front cameras • 4K video • 2,550mAh battery • 1yr RTB warranty • 71x 6.8x 143mm (WDH) • 138g

- + Beautiful design, great camera and a flawless display
- No replaceable battery or microSD slot

HTC One M9

SCORE ★★★★☆

PRICE 32GB, £483 (£580 inc VAT)

HTC's play for the smartphone throne has been somewhat overshadowed by the Galaxy S6 this month. While Samsung has radically overhauled its flagship, the HTC One M9 barely improves on its predecessor. It's faster than the One M8, and we like the new refined design. However, the screen remains the same size and resolution as before, and it isn't a patch on the S6 when it comes to performance. Battery life takes a turn for the worse and the new

20.7-megapixel camera, which lacks OIS, produces disappointing photos and video. HTC's front-facing BoomSound stereo speakers continue to impress, but this is the only area in which it bests the Samsung Galaxy S6.



Samsung Galaxy S6 edge

SCORE ★★★★☆

PRICE 64GB, £633 (£760 inc VAT)

Samsung's S6 edge grabbed all the headlines when it first launched, but it isn't worth the extra £160 premium. Sure, the curved screen looks exotic, and it adds some handy features, such as the ability to drag in from the edge to view missed calls from favourite contacts.

However, all the important parts of the S6 and S6 edge are the same. The only notable difference is the S6 edge's 2% larger battery. The increase in stamina doesn't justify the higher price, though.



Dell Latitude 13 7000 Series

A capable, long-lasting tablet and a competent hybrid, but with a few irritating niggles

SCORE 

PRICE £999 (£1,199 inc VAT) from dell.com (pcpro.link/248delllat)

As consumer laptops have become ever more exotic, business laptops have remained defiantly monochrome, fashion-free zones. That's no bad thing, but the trend for hybrid devices such as the Surface Pro 3 – half-tablet, half-laptop – is blurring the lines between work and play. Now, Dell has stepped into the fray with the Latitude 13 7000 Series. Combining a Core M-powered 13.3in tablet with a docking keyboard, this is a cutting-edge hybrid in sensible shoes.

From the outside, the Latitude 13 7000 looks every inch the business portable. The body is cast in a dark charcoal grey, and there's only the tiniest hint of glamour: the sombre exterior is shot through with a subtle silver sparkle, and a delicate chrome trim skirts around the tablet and the keyboard dock's edges.

It's a handsome, understated hybrid, but it won't win any awards for portability. Chunky strips of rubber stretching the width of the keyboard dock's underside mean that it measures 23mm thick, and the combined weight of both parts of the device tips the scales at 1.7kg.

Open the Latitude up and flick the latch beneath the screen bezel and the two parts separate: the 13.3in tablet weighs 922g alone, and the keyboard dock adds another 762g thanks to the presence of a modestly sized internal



battery. Slot the tablet home and the strong latches and wide hinge make a reassuringly solid connection. The simple mechanism feels noticeably more robust than that of the Lenovo ThinkPad Helix.

If there's a downside, it's a familiar one: with all its core components in the tablet, the Dell is top-heavy – the screen doesn't tilt as far back as a traditional laptop – and it topples back if you so much as nudge it.

■ Connectivity and display

Look around the tablet's edges and there isn't much in the way of connectivity. It's not a dead loss, however. The tablet has a separate connector for the supplied power supply, so it can be charged independently of the dock. There's a 3.5mm headset jack and a Kensington lock slot; the optional smartcard and fingerprint reader backplate adds £30 to the price.

Security is bolstered by a TPM 2 chip, and while 4G is an optional extra, Intel 802.11ac wireless and Bluetooth 4 are included as standard. There's also a competent pairing of a front-facing 2-megapixel camera and a rear-facing 8-megapixel shooter – neither is brilliant, but they dredge up enough detail for quick snaps and videoconferencing duties.



LEFT The IPS panel is bright, with superb colour accuracy

ABOVE The Latitude 13 7000 is a solid hybrid, thanks to strong latches and a wide hinge



You'll need to slot the tablet into the dock to access the two USB 3 ports, full-sized SD slot and the mini-DisplayPort output

You'll need to slot the tablet into the dock to access the two USB 3 ports, full-sized SD slot and the mini-DisplayPort output. Thankfully, Dell's retained its standard tablet-docking connector – the same used for its Latitude 10 and Venue 11 Pro tablets – so the Latitude 13 7000 is compatible with the firm's existing docking stations and a good few accessories, including Dell's Active Stylus.

Start using the Dell in anger, and it's easy to forget about any connectivity gripes. The 13.3in Full HD IPS display is a delight, and welcome proof that the days of business laptops being saddled with poor-quality TN displays are coming

to an end. The LED backlight cranks right up to a bright 393cd/m², and the IPS panel delivers a superb contrast ratio of 1,136:1. Colour accuracy is nigh-on perfect, and the panel covers 94.3%

of the sRGB colour gamut with an average Delta E of 1.37. This isn't

 Plenty of power for office work, great battery life and repairability

 Not much in the way of connectivity, and the touchpad isn't great

BATTERY: light use, 14hrs 3mins

REAL WORLD BENCHMARKS

3.4GHz Intel Core i7-2600K, 4GB DDR3 = 1

OVERALL 0.5



merely good by the standards of business laptops – it's exemplary for a laptop of any type.

■ Keyboard, touchpad and performance

In contrast with the Surface Pro 3, the Dell's design makes it a convincing laptop. The dock's well-spaced, slightly concave keys grip the finger nicely, and although typing doesn't feel as crisp as on Dell's best Latitude laptops, it's still perfectly pleasant.

Annoyingly, we encountered issues with the buttonless touchpad on our early sample, with an overly light clicking action and a tendency for the touchpad to occasionally get stuck down. We'll be pestering Dell for a replacement to see if those issues persist on final production models.

As we've come to expect, Intel's Core M makes its presence felt. It doesn't deliver enough raw power to compete with the last generation of Core i5 and Core i7 chips, but the combination of an 800MHz Core M-5Y10c and a 256GB Samsung PM851 SSD make it impossible to tell the difference in everyday use. Bootup and application-load times are speedy, and Windows feels just as responsive as we'd hope for in a premium business machine.

Indeed, the Core M only really lags behind its counterparts under heavy extended load conditions, where the lack of a fan prevents it from maintaining its maximum Turbo Boost frequency of 2GHz for any length of time. This is reflected in our benchmarks: the Dell eked out a solid Overall result of 0.5, but as expected, it dropped off the pace in the multitasking benchmarks.

The flipside is that the Core M is astonishingly efficient. With a TDP of only 4.5W, little more than an Atom CPU, the Core M helped the Dell last

14hrs 3mins in our light-use battery test with the aid of the secondary battery in the keyboard dock. Even without the dock, the tablet ran for 10hrs 18mins.

The Dell's design will also keep the IT department happy. Carefully peel off the tablet's backplate – a job requiring a thin, flathead screwdriver and a steady hand – and it's possible to get access to the BIOS battery, M.2 SSD, Wi-Fi module, empty 4G modem slot and 30Wh battery.

■ Verdict

There's much to like about the Latitude 13 7000, but we can't help wishing Dell had squeezed in a USB port. The power, battery life and features mean that the Latitude makes a competent standalone tablet, but it's annoying to have to reach for the dock every time you need a USB connection.

Still, such is the quality elsewhere that this isn't a deal-breaker. And if you already have a fleet of Dell tablets, and a good supply of docking stations, the lack of connectivity may not prove such a glaring issue.

That leaves only one major concern – the touchpad. We're keen to make sure that the issues we encountered are down to this model being a pre-production sample (check pcpro.co.uk for an update).

If your business is looking for a long-lasting, high-quality hybrid, the Dell Latitude 13 7000 Series is packed with potential. Factor in the variety of extended support and warranty options, and it's a very tempting package indeed. **SASHA MULLER**

SPECIFICATIONS

- 800MHz Intel Core M-5Y10c • 4GB RAM •
- 256GB SSD • 13.3in 1,920 x 1,080 IPS LCD display • Intel HD Graphics 5300 • Windows 8.1 • 2yr RTB warranty • 320 x 230 x 20mm (WDH) • 1.7kg (1.9kg with charger)



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Dell Alienware 17 R2

A powerful, stylish gaming laptop with the fastest mobile graphics processing unit on the block

SCORE ★★★★☆

PRICE £1,602 (£1,922 inc VAT) from dell.co.uk (pcpro.link/248Alien17)

Alienware has come a long way since it first landed back in 1996. Gone are the luminous-green laptops and giant alien skulls: the new Alienware 17 R2 oozes class. With its soft-touch matte-black and gunmetal-grey case, sharp contours and chopped-off corners, it's a beast, but a handsome one. Certainly it looks more sophisticated than rivals such as the MSI GT72 Dominator Pro.

It's slimmer too, at 37mm thick versus the MSI's 58mm, although it's no lighter: weighing a considerable 3.7kg, it feels rock-solid across every millimetre of the chassis.

For those who still crave a bit of bling, multicoloured LEDs shine along the front edge and lid, and beneath the keyboard and touchpad. Each area can be lit in different colours – pinks, reds, purples and blues – or turned off completely.

The entry-level specification, at £1,299 inc VAT, gets you a Core i7-4710HQ CPU, 8GB of RAM, a 1TB 5.400rpm hard disk and GeForce GTX 970M graphics. For £623 more, you can upgrade to the specification we have here, with a 2.8GHz Intel Core i7-4980HQ, 8GB of RAM, both a 256GB



M.2 SSD and 1TB hard disk, plus a 4GB GeForce GTX 980M.

Our review unit came with a non-touch, matte-coated Full HD display (a touchscreen will cost an extra £150). Brightness hits an impressive 347cd/m², and contrast tops out at an equally respectable 972:1. Colours do appear slightly muted to the naked eye: in our tests it covered only 86.4% of the sRGB colour gamut, with an average Delta E of 3.91 and a maximum deviation of 8.5.

Still, there aren't any noticeable response-time issues, the IPS panel provides a wide viewing angle, and the matte coating doesn't introduce any unwanted graininess.

In use, the Alienware 17 is screamingly fast. It scored a strong 1.1 in our benchmarks, and stormed through our Very High quality Crysis test (run at 1,920 x 1,080) with 85fps – 12fps smoother than MSI's Dominator Pro. At 2,560 x 1,440 and Very High detail, it fell just one frame behind the MSI with an average of 57fps. Only when we pushed up the resolution to 4K did the frame rate drop to a less than smooth 26fps.

If even that won't do, you can invest in Alienware's Graphics Amplifier – a £200 external chassis with a PCI Express x16 slot and its own 460W power supply that lets you hook up a full-sized desktop graphics card to a compatible Alienware laptop. For those looking to dump a desktop PC, this could be the killer feature of the new Alienware range.

Aside from that, connectivity is as good as you could ask for: you get four USB

ABOVE The Alienware 17 is a solid laptop with superior looks and performance

3 ports, an SD card reader, HDMI 1.4 and mini-DisplayPort 1.2 outputs, Gigabit Ethernet and a pair of 3.5mm audio jacks. Bluetooth 4 and 802.11ac make the cut, too.

On the underside, an entry panel provides access to the single 2.5in hard drive bay, the two RAM slots, the Wi-Fi card and four (yes, four) M.2 slots. In our review unit three of those slots were free, but there's no native RAID support, and no second pair of RAM slots for easy memory upgrades either. In addition, the onboard GPU is soldered onto the board, so the upgrade path is restricted.

If such things are important to you, the MSI GT72 Dominator Pro remains a strong rival: while nowhere near as pretty as the Alienware 17, it boasts better upgradability and comes with the option of up to four SSDs in RAID.

Ultimately, it comes down to which laptop fits your needs best. The MSI easily wins out on expansion and upgrade potential, while the Alienware combines gorgeous looks and better battery life with the option for future expansion via the novel Graphics Amplifier. It's a tough call to make but, if you're seeking the ultimate in laptop gaming, the Alienware 17 deserves to be on your shortlist. **SASHA MULLER**

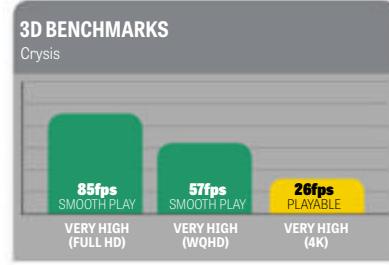
OVERALL 1.1

BATTERY: light use, 10hrs 10mins

3D BENCHMARKS

Crysis

85fps SMOOTH PLAY VERY HIGH (FULL HD)	57fps SMOOTH PLAY VERY HIGH (WQHD)	26fps PLAYABLE VERY HIGH (4K)
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SPECIFICATIONS

2.8GHz Intel Core i7-4980HQ • 8GB DDR3 RAM • 256GB SSD • 1TB HDD • 4GB Nvidia GeForce GTX 980M • 17.3in 1,920 x 1,080 display • 1yr NBD warranty • Windows 8.1 64-bit • 421x290x37mm (WDH) • 3.7kg (4.5kg with charger)

Microsoft Office 2016 IT Pro and Developer Preview

Microsoft's first public release of Office 2016 sees some welcome updates – and there's more to come

These days, any update to Office must inevitably seem quite minor – after all, the major features have been fully formed for years. So it is with Office 2016, now available as an "IT Pro and Developer Preview" for Office 365 subscribers. But incremental improvements are no bad thing: if Microsoft had rested on its laurels after Office 97, we'd have no ribbon interface, no Backstage view or OneDrive integration – and we'd still have Clippy greeting us at startup.

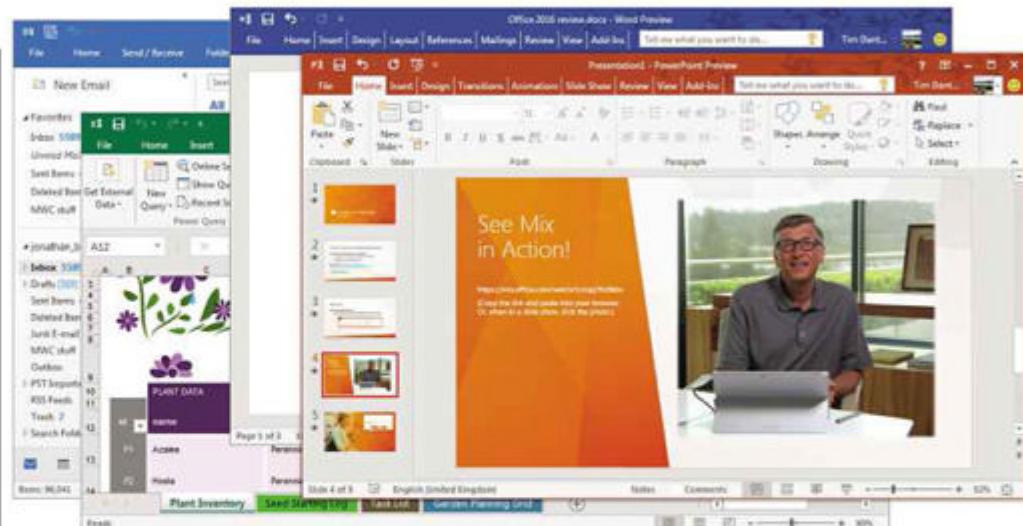
One key addition to Office 2016 could change the way you use the suite: desktop applications have now inherited the "Tell me what you want to do..." search box from the Office online applications.

Once you start using this simple feature, you'll be wondering why Microsoft didn't build it in years ago. The ability to hit Alt+Q and simply type what you're looking for – be it sparklines in Excel, drop-caps in Word or animations in PowerPoint – is a huge usability boost. Although the ribbon was originally intended to help users find the functions they were looking for, we've often found it frustrating to have to hunt for features we don't commonly use. That frustration is now gone.

The search facility doesn't merely signpost the feature you want – it lets you use it directly. Type "table" into the box in Word and a dropdown appears offering all the functions of the ribbon bar button. Want to insert a bar chart in Excel? Select your cells, type "chart" in the box, and select a chart type from the dropdown.

The new search field isn't currently in Outlook or Access – but in time we hope it will become as pervasive as the ribbon.

Cosmetically, Office 2016 is more colourful than Office 2013, with the toolbars adopting the colour coding of their logos: Word has a blue toolbar, Excel's is green, PowerPoint's is red and so on. It isn't a huge change, and the old colour schemes are still available, but we find the new look



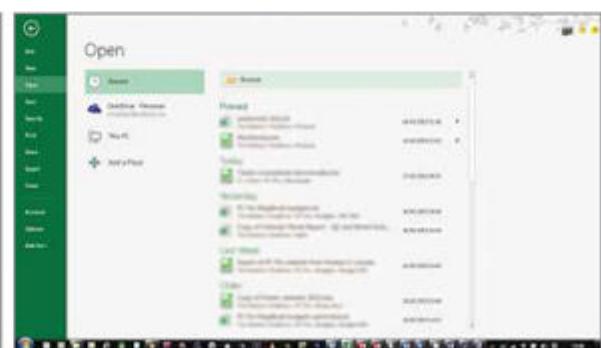
makes it easier to make sense of a crowded desktop.

Elsewhere, the Backstage view gets updated folder icons, and a re-organisation that sees the Browse button always displayed at the top of the screen. It's cleaner than it was, but we'd have preferred to see a more drastic redesign: this area has always seemed a bit of a hotch-potch rather than a properly thought-out interface.

Additionally, in Outlook 2016, when you click "Attach file", a list of recently accessed files now drops down. You can select Browse to pick any file you like, but if you've recently used a document you want to attach, it's accessible with a single click.

Office 2016 brings several improvements for corporate users. Word, Excel and PowerPoint now get data-loss-prevention features, which IT administrators can use to prevent employees leaking sensitive company information accidentally (or indeed deliberately). Similarly, Visio now supports Microsoft's Information Rights Management (IRM) tool, which can help companies control the way files are used after they're sent elsewhere, such as by restricting pasting or printing.

In Outlook, RPC synchronisation is replaced by the newer MAPI-HTTP



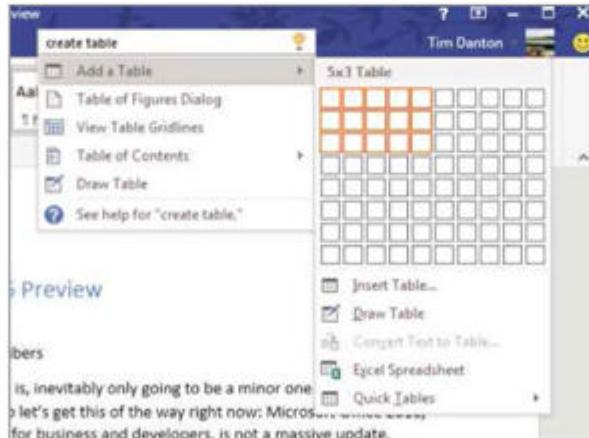
TOP Toolbars in each application take on the colour of their logos

BOTTOM Folder icons in Excel's Backstage view have been updated

protocol, so emails should arrive more quickly, and more reliably on unstable connections such as 3G links. Those on tablets or lightweight laptops will be glad to learn that you can also now restrict the local storage of email to one, three, seven or 14 days.

Finally, deployment options have been upgraded: IT administrators can now manage Office 365 subscriptions on devices remotely from the Office Admin Portal.

It's early days, but already we're finding Office 2016 easier to use than its predecessor, better looking and better equipped for modern business. It remains to be seen what else will be added before the software officially hits later this year – but we'll find out soon, as Microsoft plans to keep adding features to the preview via monthly updates. **JONATHAN BRAY**



How to get the preview

If you're an Office 365 subscriber, you can sign up to the Office 2016 preview at pcpro.link/248office2016. Needless to say, all the usual caveats concerning preview software apply. Non-subscribers can also sign up and download the software – but you won't be able to activate it, so you may only be able to try it out for 48 hours.



Microsoft Office apps for Windows 10 Technical Preview

Microsoft finally makes its selection of touch-friendly office apps available to try out

AVAILABILITY Now, from the Windows 10 Store (beta)

Having already furnished iPad and Android users with touch-friendly versions of its Office apps, Microsoft has finally thrown a bone to Windows tablet users. Well, sort of. Although polished versions of the Office apps are now in the iTunes App Store and Google Play, the touch versions of Word, PowerPoint and Excel are only available on the Windows 10 Technical Preview and are still in beta.

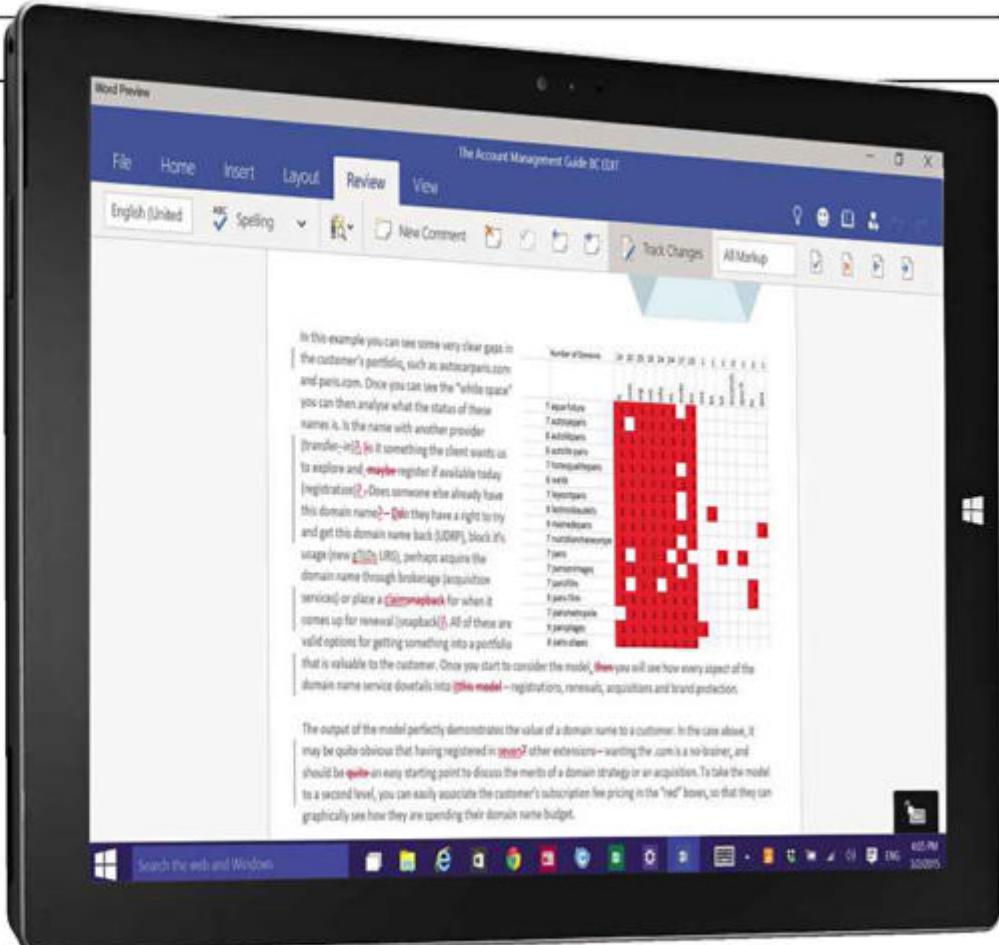
Still, they're good enough to provide a feel for what Windows 10 users will have access to when the OS launches this autumn, and how they compare to the Office apps on rival platforms. Has Microsoft saved any special treats for the loyalists?

Word

On first inspection, there's little difference between the Word apps for iOS and Android and the version for Windows 10. They offer the same tabs in the ribbon menu and a similar set of features lurking beneath. The only notable difference is that both Windows and Android have a File tab that opens the Open/Save/Share screen that will be familiar to Word 2013 users, while the iPad app tucks that behind a small arrow in the top-left-hand corner of the screen.

That consistency of design isn't a bad thing. Many Windows users will also have iPads and Android devices, and will appreciate not having to relearn a UI every time they pick up a new device. Nobody familiar with Office 2013 or any of the other Office apps will struggle to adapt, which is a bonus for businesses thinking of deploying these apps to staff.

The Word app contains only a subset of the features you'll find in the full desktop version of Word 2013, but there aren't any show-stopping omissions. There's a decent selection of templates to choose from when creating a document from scratch, and as with the other Office apps, we encountered no problems when



ABOVE The Word app for Windows 10 is similar to iOS and Android versions

opening and editing large, heavily formatted documents – something that can't be said for online services such as Google Drive.

There are one or two advantages of running the Word app on Windows, as opposed to the other platforms. The choice of fonts is greater, and there are no device-specific fonts like there are on the iPad, which can cause compatibility issues later. Assuming you have OneDrive or Dropbox synchronised to your Windows device, access to documents when offline is also easier, since you get full access to the file system; on Word for the iPad, you have to open documents in the app before you go offline.

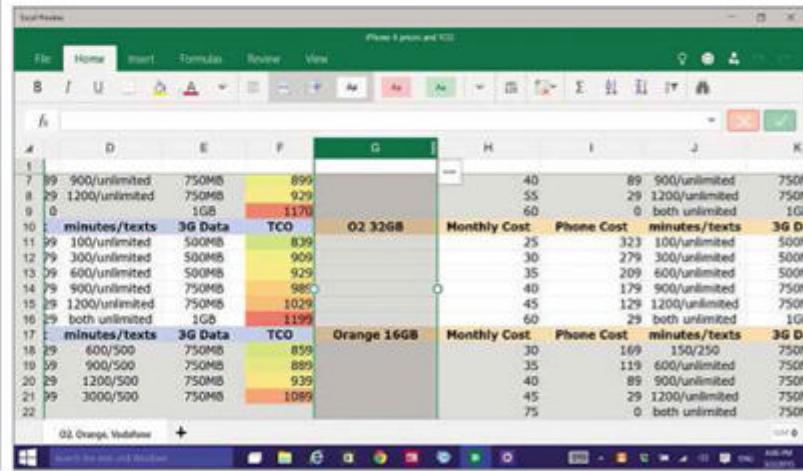
On the downside, there are currently fewer options for handling tracked changes than there are in the iOS version of Word, and the design of the button doesn't make it clear if

tracking is switched on or off. We'd also urge Microsoft to do some work on the default software keyboard in Windows 10: it swallows half the screen when you're typing in landscape mode, making it difficult to navigate around documents.

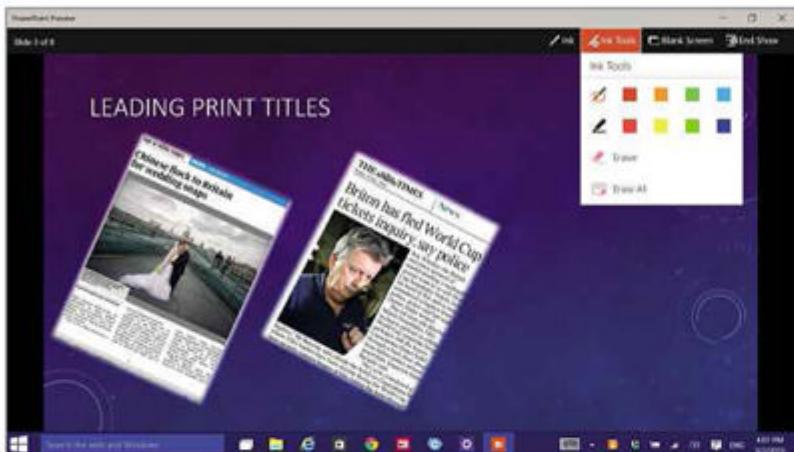
Nevertheless, we'd be perfectly happy to write, tweak and edit documents using the Word app.

Excel

It's much the same story for Excel as Word, with little visible difference between the Windows and other versions of the app. Manipulating a spreadsheet on a pure touchscreen device could have been tricky, but Microsoft has done a good job of making Excel finger-friendly without fundamentally damaging the utility of the spreadsheet. Entire columns or rows can be moved by pressing down



RIGHT Moving entire columns in Excel is simple – just press down on the header and drag the column to the desired position



ABOVE PowerPoint needs work; its Presenter mode is lacking when compared to the iPad version

on the header and dragging the row or column to the desired position; autofit can be applied to a row or column by simply double-tapping the header.

These touch shortcuts take a little learning, but soon become second nature, and make manipulating even the biggest of spreadsheets simple. That said, we're grateful for the prominence of the Undo button in the top-right corner to help correct touch-induced errors.

Composing formulae is handled well in the app. The Formulas tab provides shortcuts for different types of formulae (Financial, Logical, Date & Time and so on), and once you've chosen the relevant formula you select which cells to apply it to by simply prodding them in turn; the keyboard isn't really necessary. That said, we note that Microsoft has devised a keyboard specifically for Excel on both iOS and Android, which provides a numerical keypad, cursor keys for easily moving between cells and keys for common functions. As yet, there's no such facility for Windows.

As with all the other Office mobile apps, some features are off-limits if you're building a spreadsheet from scratch. There are no conditional-formatting options, for example, nor options to create pivot tables, although they'll continue to work as expected if they're already in an imported spreadsheet.

■ PowerPoint

PowerPoint is the most disappointing of the new Windows apps. It's perfectly adequate for editing existing slideshows, or even creating presentations from scratch. There's a reasonable selection of templates to choose from; image handling is excellent, with transparent guidelines to make sure photos are lined up properly with text; and there's a good stock of transitions and effects for those who like to give it some visual pizzazz. The only major omission is the inability to insert

videos or play clips already inserted into slide decks.

What really lets down the Windows 10 app is the Presenter mode. The tablet is the perfect tool for presenting your PowerPoint slides, letting you address the audience while swiping through slides and using your slate as a prompter. However, it isn't a patch on its iPad equivalent. On the iPad, you can have your existing slide in a large window, with thumbnails of upcoming slides running along the foot of the screen and your presenter notes running down the edge. You can't even see your notes in the Windows version, and you have to pinch to zoom to get the thumbnails, which is awkward.

The Windows app does include the same virtual laser-pen and inking options as the iPad, but the controls are difficult to access, and we often found ourselves accidentally advancing to the next slide when trying to activate them. We hope Microsoft gives the Presenter mode a good dollop of elbow grease before the apps are finalised; we wouldn't want to stand on stage delivering a presentation with the current tools.

■ OneNote

OneNote has been available as a Windows 8 touch app for some time, but there's a new preview version in the works. We can't say we're impressed. First, it adopts a different layout to the main OneNote Windows

How will the apps look on phones and compact tablets?

Windows 10 isn't only for PCs, laptops and tablets. The same codebase will also run on Windows 10 phones and compact tablets, as will these universal Office apps. However, their appearance is very different on these small-screen devices.

The ribbon menu used in the tablet apps simply doesn't work on small screens that are predominantly used in portrait mode. Instead, Microsoft has built the ribbon menu into the app bar at the bottom of the screen. This overlays the menu options (Bold, Underline, Bullets, Numbering and so on) over the top of the document; you select the feature you want to use, hide the ribbon menu, then apply it to the document laying beneath. Users can scroll through the ribbon tabs on a dropdown menu.

Crucially, Microsoft also reformats documents so that they fit on the mobile screen. This means images may be positioned, or wrap around text, in a way that's different to how they would on a PC or laptop screen. You almost certainly won't want to be doing any heavy editing on phones or compact tablets, therefore, as the layout of your document could be altered in unexpected ways.

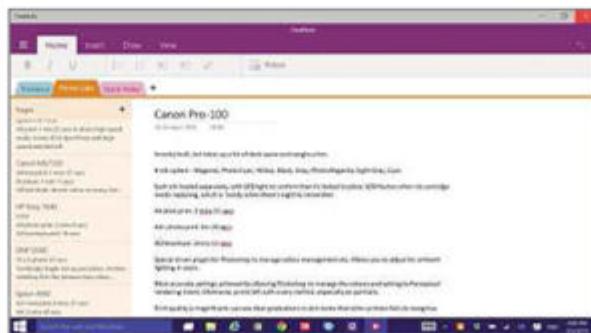
application, with individual pages listed down the left, rather than the right, of the screen, and with previews of the page contents included. This means only four or five page titles can be displayed onscreen at a single time, resulting in a lot of vertical scrolling.

It also had a bug in our tests, where notebooks that had been previously renamed were still displaying their old names. These new names showed in every other version of OneNote we've tested, suggesting it's a gremlin that Microsoft needs to sort out – and sharpish, if it wants to avoid any ugly synchronisation errors.

■ Verdict

Overall, we're not bowled over by the Office apps on Windows. At best, they're as good as the equivalents for iOS and Android. In some cases, such as with PowerPoint and OneNote, there's a lot of work to be done. While we're mindful that these are works in progress, we can't help noticing that Windows users are being offered almost nothing that hasn't already been released on rival platforms. If even Microsoft can't provide compelling reasons to choose Windows over iOS or Android, what hope have third-party developers got?

That said, the Office apps for Windows could prove valuable for Windows tablet users in one crucial regard: they take up a fraction of the storage space of the full desktop applications. The Word preview takes up 25.8MB of disk space on our test tablet, for example, while Office 2013 consumes 3GB on our laptop. For those running tablets with only 16GB or 32GB of storage, that alone could make the difference. **BARRY COLLINS**



ABOVE The layout of the OneNote app doesn't match the desktop app

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LABS



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Low-cost laptops

A new breed of super-cheap laptop is emerging, and we have seven of the very best on test this month

Only a few years after the death of the netbook, budget laptops are having a renaissance. The original breed of sub-£250 laptops was seen off by the rise of tablets, but the idea of the low-cost laptop never wholly went away. While Google's Chromebooks took a while to gain traction, their combination of bargain-basement pricing and web-focused functionality has helped them gradually develop a foothold in homes and – particularly – schools. Now Microsoft has taken note, last year releasing a special OEM version of Windows 8.1 to hardware manufacturers that costs nothing, but which pushes users towards Microsoft's online services such as OneDrive, Office 365 and Bing.

Windows 8.1 with Bing has changed everything. It's given Microsoft's partners a way to compete with Chromebooks without leaving the familiar Microsoft ecosystem, and it's no surprise that the majority of these laptops share key elements with Chromebooks from the same manufacturer, sometimes even using the same chassis.

This is why today's low-cost machines won't go the way of the netbook. Those older devices failed because they made too many compromises on performance and usability, but the latest Chromebooks and Windows systems don't make

the same mistakes. They come with decent 11.6in, 13.3in and even 15.6in screens, with a standard 1,366 x 768 resolution that's spacious enough to get real work done. Their dual- and quad-core processors can run Office apps or keep several browser tabs open without everything slowing to a crawl. Their touchpads and keyboards aren't cramped and unusable – and, perhaps most importantly, Windows 8.1 and Microsoft's cloud-based services are a much better fit for these devices than Windows 7 and local applications ever were for the netbook.

You still need to be realistic about what you're getting. On the pages that follow, you won't find Core i3 or i5 CPUs; all of these laptops are based on Intel's bargain-basement Bay Trail Atom and Celeron processors. Expect 2GB of RAM as standard, although a few ship with 4GB. It is possible to run heavyweight applications such as Adobe Photoshop Lightroom or Sony Vegas on one of the models featured in this Labs, but it will be slow.

Generally, you're better off with the Celeron N2830 or N2840 processor, rather than the Atom Z Series used in some of the cheapest models. While there's no fundamental difference in the Silvermont architecture used in each SoC (system on a chip) – and the Celerons are only dual-core, not quad-core – the cores in the Celeron processors run at much ↗

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LEFT Google introduced Chromebooks to fill a gap in the market

faster clock speeds. When you're trying to run more demanding apps, this matters.

As far as the displays go, most manufacturers are opting for an 11.6in screen for their cheapest budget models, with a larger 13.3in variant available for £30 to £50 more. Either way, you'll be looking at the same resolution of 1,366 x 768. Quality varies dramatically, and you can't expect a sub-£200 laptop to match a £750 MacBook Air – however, while some of these laptops have drab screens with poor colour accuracy and woeful contrast, a growing number punch well above their weight, with good brightness levels, ample clarity and respectable viewing angles.

From a distance, some budget laptops look similar to Ultrabooks, but they won't feel like them in the hand. What looks like aluminium will more often be a coated plastic, and the quality of the construction can vary from solid to distinctly creaky – thin shells, weak hinges, poorly reinforced corners and over-flexible lids are more common

ABOVE RIGHT Not only are they cheap, Windows with Bing laptops also often come with a one-year subscription to Office 365

RIGHT Low-cost laptops may be lacking in storage; they're intended to be used primarily with cloud-based services

How we test

We tested all the Windows laptops with our own PC Pro benchmarks, using real-world applications such as Microsoft Office, Adobe Photoshop and Acrobat Reader, Apple iTunes and Sony Vegas Pro to analyse how each would perform in real-world use. Our tests look at responsiveness, media performance and multitasking, with performance compared to our reference platform – a 3.4GHz Core i7-2600K with 4GB of DDR3 RAM – and the three scores averaged to form an Overall score. In addition, we tested all the laptops using Futuremark's Peacekeeper browser benchmark in order to evaluate performance in comparison to Chromebooks. We used the free dispicalGUI tool with a colorimeter to check screen quality. Finally, we ran two battery-rundown tests, one simulating a light web-browsing workload, the other simulating more demanding 3D-rendering applications.

"While some of these laptops have drab screens, a growing number punch well above their weight with good brightness and ample clarity"

than we'd like. It's always worth reading reviews and – where possible – getting hands-on before you buy. What's more, while these are

lightweight machines, suitable for taking with you everywhere, it's worth investing in a good-quality protective sleeve or case.

Connectivity is basic. Although even the cheapest laptops will include 802.11n Wi-Fi, we've yet to see one that supports the new 802.11ac standard, and built-in Ethernet is rare. Avoid models that don't incorporate a USB 3 port – this is valuable for extra storage – and look out for an HDMI output too. This gives you the flexibility of connecting your laptop to a TV or monitor if you need more screen space for either work or entertainment.

One thing that isn't a concern is battery life. A combination of a small screen, power-efficient processor and

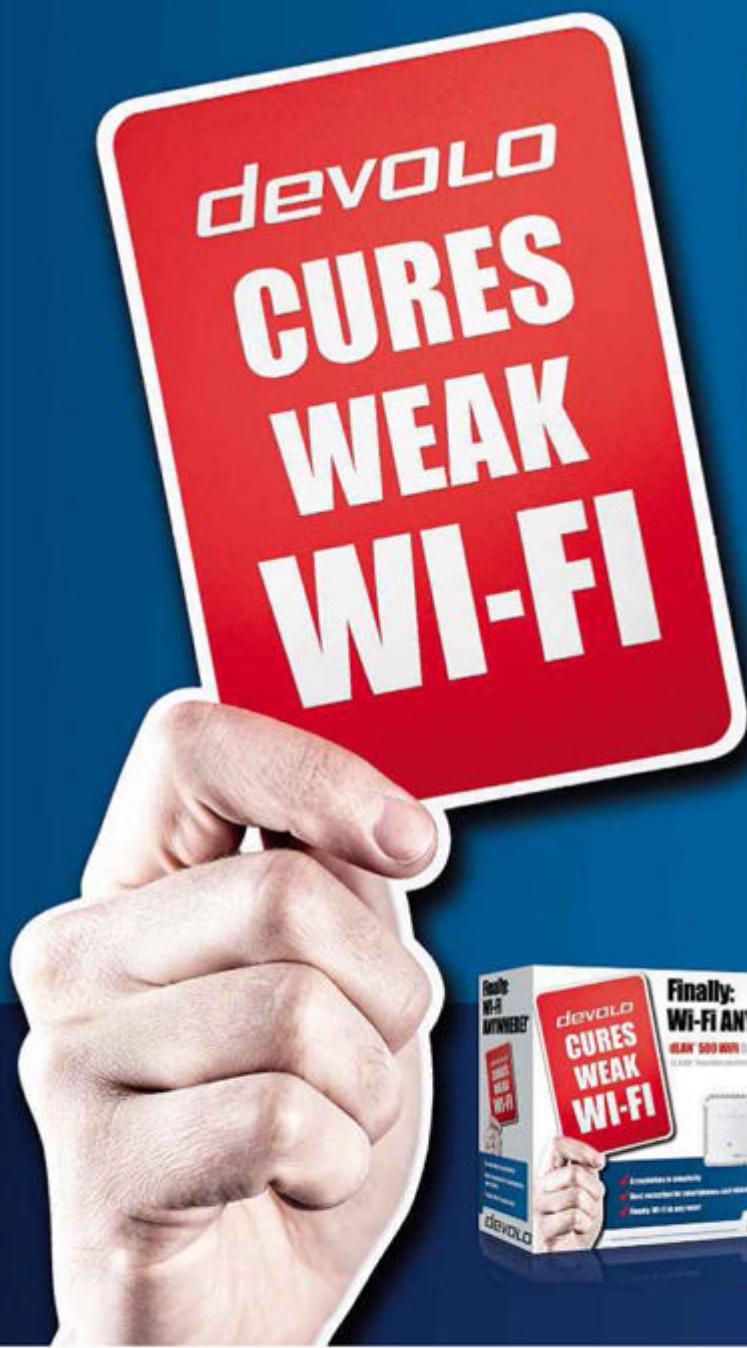
compact, high-capacity battery means the best budget laptops will handle ten hours or more of web browsing or basic productivity tasks without keeling over. Some don't fare quite as well, so ensure you're aware of your requirements before you buy.

The single biggest issue with these laptops is storage. A few ship with mechanical hard disks, but more are aping Chromebooks and selling with a 32GB eMMC flash drive, which will then have much of its space occupied by Windows, any preinstalled apps and a hidden recovery partition. The idea is, of course, that you don't store applications and data locally, but cache them briefly as they upload to and download from services running in the cloud.

In practice, there's enough space to install some apps locally and store documents on your local drive, but be aware that you might need to change the way you work and play to suit your new machine.

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* Required: broadband Internet connection, router and active power sockets within one property.



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The Network Innovation



Budget laptops: the processors behind the new breed

Architectural improvements by both Intel and AMD will ensure we continue to see increasingly powerful devices, but without increasing costs

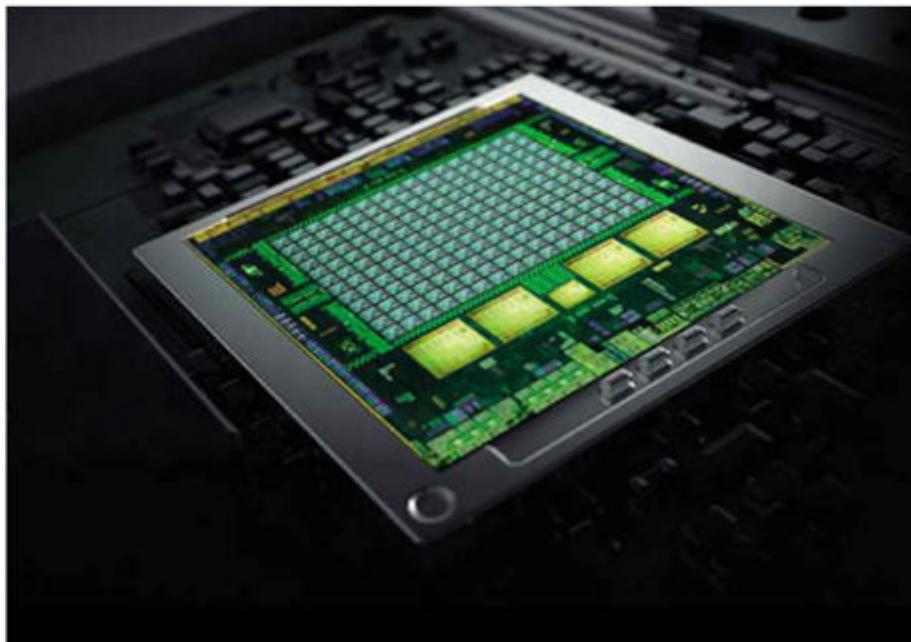
Intel's Atom processors were always intended to expand the potential of compact, low-cost PCs, but it was only with 2012's Clover Trail platform that the processor really began to deliver on its promise. Today, Clover Trail's successor, Bay Trail, brings us fully capable laptops at remarkably low prices.

That's thanks to the underlying Silvermont architecture, launched in 2013, which represents a few firsts for the Atom line-up. For a start, it's the first Atom processor to embrace the 22nm 3D Tri-Gate technology introduced in Intel's mainstream Core line with 2012's Ivy Bridge processors. What's more, it's Intel's first low-power SoC (system on a chip) to have out-of-order execution (OoOE).

Previously, Atom processors executed instructions in sequence from one long list, which meant that, say, execution resources could be left sitting idle while an instruction waited for the data it needed to complete. OoOE allows instructions to be fetched and executed out of order, so that as many resources are being used as much as possible. The result is a more efficient processor: Intel claims that Silvermont offers a 30% increase in performance over Atom's last microarchitecture based on this one enhancement alone.

Add to this support for more instructions, including SSE4.1 and 4.2, POPCNT and AES-NI, and Silvermont is now roughly in line with where the Core architecture was in 2010; not bad for processors with a TDP that, in the tablet-focused Bay Trail-T line, can go as low as 2W.

It's here that things become confusing. Where Silvermont's predecessor, Bonnell, was used exclusively in Atom processors and SoCs, Silvermont has proved fast enough to be extended to Intel's Celeron and Pentium lines. Buyers of low-cost laptops could be choosing between Bay Trail-T Atom- or Bay Trail-M Celeron-based laptops, unaware that they use the same core technology (albeit running at different speeds). What's more, it means there are both low-power Silvermont and



ABOVE Nvidia's Tegra K1 SoC provides strong competition for Intel in the Chromebook and Android laptop space

more performance-focused Haswell and Broadwell processors within the Celeron and Pentium lines – although these are differentiated by the sockets they support and the systems they're designed to power.

Airmont takes wing

While it's still the mainstay of low-cost, low-power PCs and tablets, Silvermont is due to be replaced very

soon by an enhanced version – Airmont – which we should begin to see in new devices by the end of 2015, if not sooner.

Airmont sees Intel adopting the same "Tick-Tock" pattern

with which we're familiar from its full-power laptop and desktop processors – the "Tick" representing a die shrink of the process technology and the "Tock" representing a redesign of the microarchitecture. Airmont is effectively Silvermont shrunk to the same 14nm process used in Intel's new Core M processors, allowing Intel to ramp up speeds without increasing power and thermal requirements, or to deliver the same speeds for a lower power consumption.

Interestingly, we'll see Airmont in two formats: Cherry Trail, a SoC aimed at the tablet market, and Braswell, a derivative of Cherry Trail aimed at low-cost laptop and desktop PCs. What's more, both SoCs will see a boost in graphics performance over the older Bay Trail-M and Bay Trail-T lines.

This should put the GPUs in the Atom and low-end Celeron processors on the same level as Ivy Bridge in 2012, while also adding support for DirectX 11.1, OpenGL 4.2 and OpenCL 1.2. In short, while you're unlikely to be playing the latest Call of Duty on a low-end laptop, Cherry Trail and Braswell should have a modicum of GPU horsepower and be capable of handling older, less demanding 3D apps and games.

Braswell is the key processor line for laptops, and will probably see Celeron and Pentium branding, much like Bay Trail-M. It's expected to use two to four Airmont cores combined with the eighth-generation graphics core, plus up to 2MB of L2 cache and a dual-channel DDR3 controller. And beyond? Well, challenges with the 14nm architecture and low-yield issues have seen Airmont processors

"Cherry Trail and Braswell should have a modicum of GPU horsepower and be capable of handling older 3D apps and games"

pushed from Intel's 2014 roadmap to this year, and its successor, Goldmont, delayed until 2016. Goldmont – the Tock to Airmont's Tick – should deliver a new microarchitecture and other enhancements, potentially bringing even more CPU and GPU performance within the same power range and at the same low price.

The AMD alternative

Unlike the tablet and smartphone market, the laptop market is one that Intel still dominates – but it doesn't have the field entirely to itself. AMD has its own E-Series line of APUs in this sector, and while they haven't been hugely successful, you'll find the latest Beema dual-core SoCs in some budget models from Lenovo and Toshiba. Beema is based on AMD's Puma architecture – an enhanced version of the Jaguar architecture used in the Xbox One and PlayStation 4 games consoles – with OoOE and a Radeon R2, R3 or R6 GPU. These GPUs use the same Graphics Core Next (GCN) architecture as AMD's mainstream graphics cards and APUs, albeit with a comparatively low 128 Radeon Cores, and a much lower GPU clock speed.

It's expected to be replaced by Carrizo-L later this year, with up to four streamlined Puma+ cores, faster GCN 1.2 compute units and support for AMD's Mantle API and

DirectX 12. While AMD is stuck with 29nm process technology at a time when Intel is moving down to 14nm, it hopes its architectural improvements will see Carrizo-L better equipped to take on Cherry Trail and Braswell processors.

Nvidia: ARM to the Max

Meanwhile, in the Chromebook and Android laptop market, Intel faces an unexpected rival: graphics giant Nvidia. Better known for 2013 tablets such as Google's Nexus 9 and Nvidia's Shield, the Tegra K1 processor has now crossed over into Acer and HP Chromebooks, including the HP Chromebook 14 G3 and the Acer Chromebook 13.

Packing four ARM Cortex-A15 cores and a battery-saver core into a 28nm chip gives the K1 plenty of processing power, but with 192 Kepler GPU cores it's the graphics performance where it really makes its presence felt. At the moment there are compatibility issues with some Chrome OS apps, particularly those using Google's Native Client technology to run in the browser, but these may be overcome with time.

Nvidia has already announced its next-generation Tegra X1 processor, with four ARM Cortex-A57 cores and four ARM Cortex-A54

"The Nvidia Tegra X1 packs in 256 of AMD's latest Maxwell cores, making it roughly as powerful as a last-generation console"

BELOW The Nvidia Tegra X1 processor could make the next generation of Chromebooks viable gaming machines – with the right software

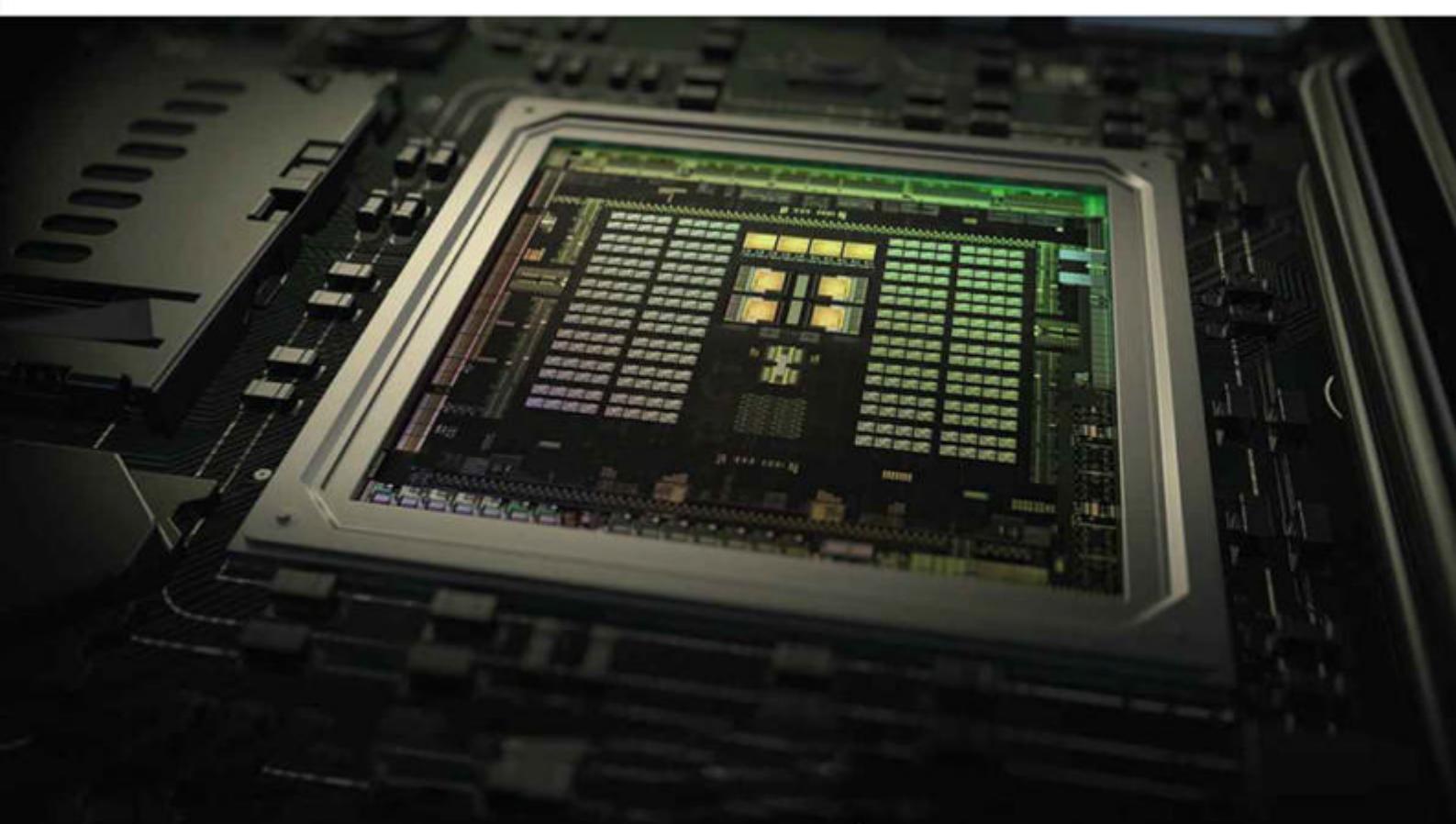
cores arranged in what ARM calls a big.LITTLE configuration, where the faster cores handle more demanding tasks and the smaller, more power-efficient cores swing into action for more basic or background tasks.

Again, though, graphics performance looks set to be the key differentiator, with the X1 packing in 256 of Nvidia's latest Maxwell cores, along with other GPU enhancements that make it roughly as powerful as a last-generation games console. That could make a new generation of Chromebooks even more compelling – providing there's the software to make the most of all that power, which is by no means certain.

What the future holds

While high-performance processors aren't going anywhere, in the next few years it's likely to be the low-power, low-cost market where the real action takes place, as the lines between smartphone, tablet and laptop technology continue to blur.

That's good news for everyone: having faster, more capable processors available at lower prices should make it easier for the big manufacturers to produce laptops and other devices that cut costs without cutting corners. And that means the budget laptops we're seeing now shouldn't be a netbook-style flash in the pan.





Product type	Windows laptop	Windows laptop	Windows laptop
Acer Aspire ES1-111M	Asus EeeBook X205TA	Asus X200MA	
Overall	★★★★★	★★★★★	★★★★★
Information			
Part code	NX.MRSEK.001	X205TA-BING-FD005BS	X200MA-KX366BA
Price (inc VAT)	£148 (£178)	£146 (£175)	£167 (£200)
Delivery (inc VAT) ¹	Free	£4 (£5)	Free
Manufacturer	acer.co.uk	asus.com/uk	asus.com/uk
Supplier	amazon.co.uk	laptopsdirect.co.uk	pcworld.co.uk
Dimensions (WDH, including feet)	291 x 211 x 21mm	286 x 193 x 18mm	302 x 200 x 26mm
Weight (with charger)	1.29kg (1.66kg)	950g (1.1kg)	1.24kg (1.39kg)
Service & support			
Warranty ²	1yr RTB	1yr RTB	1yr RTB
Manufacturer reliability/ customer support score ³	85% / 74%	85% / 78%	85% / 78%
Core components			
Processor	Dual-core 2.16GHz Intel Celeron N2840	Quad-core 1.33GHz Intel Atom Z3735F	Dual-core 2.16GHz Intel Celeron N2830
RAM fitted	2GB DDR3L (4GB tested)	2GB DDR3L	2GB DDR3
Display			
Size & finish	11.6in glossy	11.6in glossy	11.6in glossy
Resolution	1,366 x 768	1,366 x 768	1,366 x 768
Touchscreen (type)	✗	✗	✗
Graphics chipset	Intel HD Graphics	Intel HD Graphics	Intel HD Graphics
Video outputs	HDMI	micro-HDMI	HDMI; VGA
Drives			
Storage capacity	32GB	32GB	500GB
Storage type	eMMC flash	eMMC flash	HDD
Optical drive	✗	✗	✗
Battery			
Type (capacity)	Sealed (2,670mAh)	Sealed (not stated)	Sealed (3,300mAh)
Ports & connections			
Wireless connectivity	Single-band 802.11n; Bluetooth 4	Dual-band 802.11n; Bluetooth 4	Dual-band 802.11bgn; Bluetooth 4
Wired Ethernet speed (Mbps/sec)	1,000	N/A	10/100
Memory card reader	SD	microSD	SD
Ports	3.5mm headphone jack; USB 3; USB 2	2 x USB 2; 3.5mm headphone jack	3.5mm headphone jack; USB 3; 2 x USB 2
Other features			
Webcam	0.9MP	0.3MP	0.9MP
Backlit keyboard	✗	✗	✗
Touchpad toggle on/off	✓ (keyboard shortcut)	✓ (keyboard shortcut)	✓ (keyboard shortcut)
Volume control	✓ (keyboard shortcut)	✓ (keyboard shortcut)	✓ (keyboard shortcut)
Software			
Operating system	Windows 8.1 with Bing 64-bit	Windows 8.1 with Bing 32-bit	Windows 8.1 with Bing 64-bit

¹ Mainland UK only. ² Parts and labour, UK mainland, unless otherwise stated. ³ Laptop reliability/customer support rating in the reader-voted PC Pro Excellence Awards 2014. See [pcpronlink/pcproawards2014](#).



LABS WINNER		RECOMMENDED	
Windows laptop	Windows laptop	Chromebook	Windows laptop
HP Stream 11	Lenovo B50-30	Toshiba Chromebook 2 CB30-B-104	Toshiba Satellite CL10-B

11-d007na	MCA2WUK	CB30-B-104	PSKVEE-00300NEN
£150 (£180)	£142 (£170)	£225 (£270)	£167 (£200)
Free	Free	Free	Free
hp.co.uk	lenovo.com/uk	toshiba.co.uk	toshiba.co.uk
store.hp.com/ukstore	ebuyer.com	johnlewis.com	argos.co.uk
300 x 206 x 20mm	380 x 262 x 25mm	320 x 214 x 19mm	289 x 199 x 20mm
1.29kg (1.6kg)	2.32kg (2.7kg)	1.35kg (1.6kg)	1.1kg (1.4kg)

1yr RTB	1yr RTB	1yr RTB	1yr RTB
83% / 76%	84% / 75%	84% / 73%	84% / 73%

Dual-core 2.16GHz Intel Celeron N2840			
2GB DDR3L	4GB DDR3L	4GB DDR3	2GB DDR3

11.6in glossy	15.6in glossy	13.3in glossy	11.6in glossy
1,366 x 768	1,366 x 768	1,920 x 1,080	1,366 x 768
Intel HD Graphics	Intel HD Graphics	Intel HD Graphics	Intel HD Graphics
HDMI	HDMI; VGA	HDMI	HDMI

32GB	500GB	16GB	32GB
eMMC flash	HDD	eMMC flash	eMMC flash
	DVD writer		

Sealed (Unknown)	Replaceable (2,200mAh)	Sealed (not stated)	Sealed (3,684mAh)
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Single-band 802.11n; Bluetooth 4	Single-band 802.11n; Bluetooth 4	Dual-band 802.11n; Bluetooth 4	Single-band 802.11n; Bluetooth 4
N/A	1,000	N/A	N/A
SD	SD	SD	SD
3.5mm headphone jack; USB 3; USB 2	3.5mm headphone jack; USB 3; 2 x USB 2	3.5mm headphone jack; USB 3; USB 2	3.5mm headphone jack; USB 3; USB 2

0.9MP	0.9MP	0.9MP	0.9MP
✓ (keyboard shortcut)	✓ (keyboard shortcut)	✓ (keyboard shortcut)	✓ (keyboard shortcut)
✓ (keyboard shortcut)	✓ (keyboard shortcut)	✓ (keyboard shortcut)	✓ (keyboard shortcut)

Windows 8.1 with Bing 64-bit	Windows 8.1 with Bing 64-bit	Chrome OS	Windows 8.1 with Bing 64-bit
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HP Stream 11

A well-balanced, attractively designed laptop that's the pick of the small-screen budget bunch

SCORE ★★★★★

PRICE £150 (£180 inc VAT) from store.hp.com/ukstore (pcpro.link/248hpstream)

Even were there nothing else to recommend the Stream 11, its eye-catching design would win it many fans. HP's 11.6in, Windows 8.1 with Bing budget laptop comes in a choice of vibrant blue or magenta, with a chassis measuring just under 20mm thick and weighing 1.29kg.

It isn't as slim and light as the Asus EeeBook X205TA, but the plastics have been treated with a powdered matte finish that give it an expensive look. The Stream 11 feels solid and robust, and is well balanced, both on the desk and on the lap. While we're not wholly sure about the graduated colours on the keyboard surround, there's a sense of fun to the styling.

The good news continues when you power it up. The Stream 11's 11.6in screen has the usual 1,366 x 768 resolution, but it's one of the best panels on test, with decent viewing angles, a maximum brightness of 261cd/m² and reasonably accurate colours. It's bested by the Toshiba Chromebook's Full HD screen, but it's on a par with most models here. On a £400 laptop, we might complain about crushed blacks and average contrast, but we're prepared to cut this £180 laptop some slack.

ABOVE HP's £180 laptop punches well above its weight



"The keyboard's good-sized Scrabble-tile keys are crisper and easier to work on than most rivals here"

While the HP's speakers carry the Dolby DTS branding, we were disappointed by the quality of the audio. While there's more low-end power and depth of tone than with many small laptops, it's tinny and heavy on the mid-range, with a tendency to distort at higher volumes.

Ergonomics and connectivity

The Stream 11 fares better on the ergonomic front. The touchpad is

96mm wide with integral buttons, and while it feels a bit sluggish at its default settings, move the pointer speed up a notch and it works perfectly well. We particularly like its silky-smooth surface. The keyboard is better still: nicely spaced, with good-sized flat Scrabble-tile keys, it's crisper and easier to work on than the keyboards on most



1 The HP Stream 11 may be a low-cost laptop, but the blue powder-coat finish lends it a more expensive look and feel. For those who don't like this colour, it's also available in magenta

2 & 3 Connectivity is pretty standard on the HP Stream 11, but all the basics are covered, with one USB 2 and one USB 3 port, plus a full-sized HDMI output and an SD slot

4 There isn't much wrong with the ergonomics of the HP Stream 11. The keyboard is sensibly laid out, and its crisp, positive key action means it's more comfortable to type on than most rivals. The large touchpad is just as good: it has a silky-smooth surface and tracks the finger accurately

rivals here, and there isn't much bounce in the base as you type, either.

The price may be low, but HP hasn't cut corners on the connectivity front. With one USB 2 and one USB 3 port, plus an HDMI output, a headphone socket and a full-sized SD slot, the Stream 11 is as well equipped as most Ultrabooks – something that can't be said about the similarly priced Asus EeeBook. Storage could be a problem, however, with only 17.3GB of the 32GB eMMC flash drive's space available – but bear in mind these machines are designed to work with lightweight apps and cloud services. HP also includes Office 365 Personal with 1TB of OneDrive storage for a year, although it will cost you £60 per year thereafter.

Not all the extras are so welcome. The Stream is stuffed with apps, and shortcuts abound, many of which seem to do little more than act as a

portal to third-party services; if we want to use Deezer, we'll download the Deezer app, thanks. While the laptop comes with a year's free use of HP Connected Music's radio playlists, it's no match for Spotify.

■ Core hardware

In terms of specification, the Stream 11 matches the Acer and Toshiba laptops, with an Intel Celeron N2840 processor and 2GB of RAM. The dual-core Bay Trail-M CPU is fine for mainstream applications and will make a good fist of more demanding apps, although video-editing, high-end graphics apps and the latest games are still firmly off the menu. The HP scored higher in our Real World Benchmarks than its Windows 8.1 rivals, however, and came closest to the Toshiba Chromebook in the Peacekeeper browser-based test. It feels snappy in everyday use.

Battery life sees the HP fall behind the Acer Aspire ES1-111M, but with almost ten hours in our light-use test and close to six hours in heavy use, there's enough juice to get most people through a working day.

■ Verdict

In the HP Stream 11 we have a good-looking, well-built laptop, with a decent screen and reasonable battery life at a price that shouldn't be feasible. It's more versatile than a Chromebook, working brilliantly with online apps, but still able to run Windows software if you're sensible about your requirements or pair it with an external USB 3 hard disk. As a result, while the Toshiba Chromebook offers better hardware and a superior screen, the Stream 11 outdoes it for sheer value for money. It's the best sub-£200 laptop that money can buy.



Acer Aspire ES1-111M

An impressive display and excellent battery life lift this otherwise average budget laptop

SCORE

PRICE £148 (£178 inc VAT) from amazon.co.uk (pcpro.link/248aceraspire)

There's something appealingly stripped back about the design of the Aspire ES1-111M. Where some of Acer's previous budget laptops and Chromebooks look and feel like My First Ultrabook, this one is all about the bare essentials.

The base still feels lightweight, and there's too much flex in the lid, but overall the construction is solid, and the matte textures and rubber feet mean it sits well on both a desk and your lap. At just over 21mm thick and 1.29kg in weight, the ES1-111M is light and portable.

The screen is among the best we've seen on a budget laptop. Viewing angles could be wider – colours fade once you move off-centre – but the brightness level of 273cd/m² is impressive, even if it comes at the cost of darker greys and deep blacks. Images look crisp and punchy, while movies have plenty of impact. Although colour accuracy is only average, the ES1-111M still manages to

ABOVE The ES1-111M's matte finish and rubber feet make it sturdy whether sat on a desk or your lap

cover 66.2% of the sRGB colour gamut; not bad by budget laptop standards.

The speakers have their plus points, with a little more space and clarity to the sound than you might expect. However, as soon as the drums kick in or an action scene commences, you'll be aware of their limitations – there's next to no bass response.

Ergonomics get off to a good start with the responsive touchpad, which is impressively broad for an 11.6in laptop, measuring 104mm across. Sadly, things take a nosedive when it comes to the keyboard. The feel is horribly spongy, and there are some oddities in the layout, including tiny cursor keys that double as volume and brightness controls, and the fact that

what appears to be the Return key is split between return and backslash functions. It isn't ideal for getting work done.

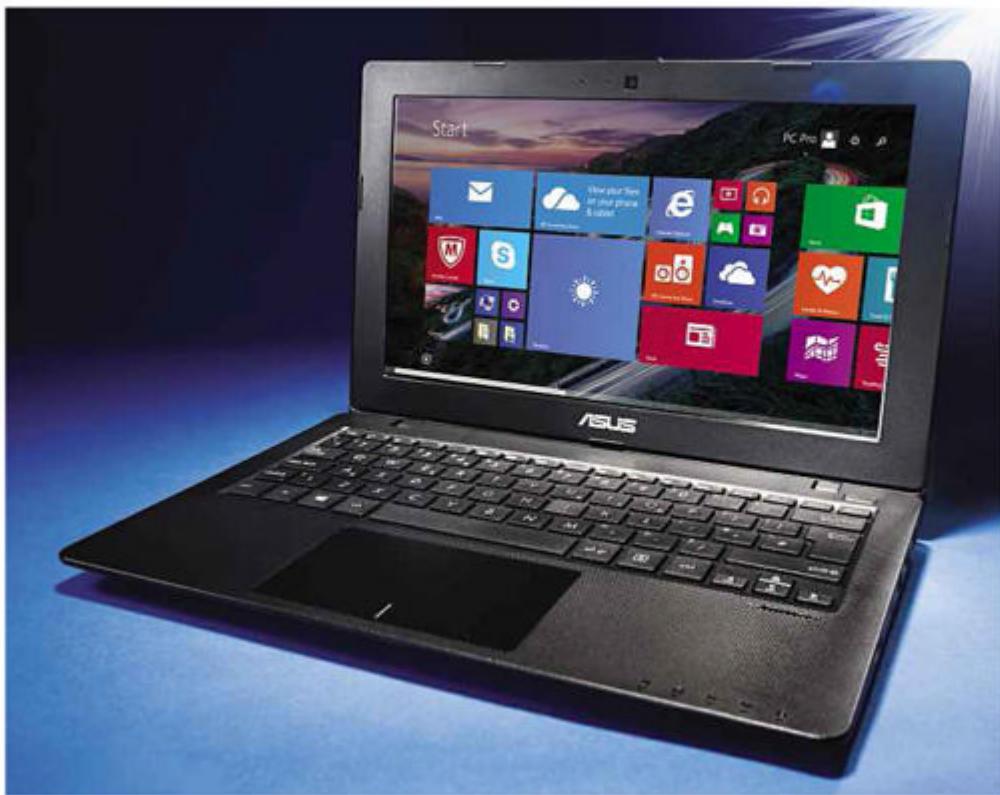
Unusually, most of the connectivity is at the rear of the laptop, with HDMI and Gigabit Ethernet ports, plus one USB 2 and one USB 3 port, while an SD slot and a headphone socket sit along the left-hand edge. The ports at the back are a bit cramped, though – and you may well express the same view about the Acer's eMMC storage. Only 11.2GB is available once Windows 8.1 with Bing, the recovery partition and Acer's usual mountain of bloatware are accounted for. The latter does include some worthy apps, including older versions of CyberLink's video- and photo-editing packages; elsewhere the selection isn't so palatable.

Performance is good, with a Celeron N2840 CPU perfectly capable of handling workloads that aren't too demanding. However, we noticed that while Acer ships the ES1-111M with 2GB of RAM as standard, our test sample shipped with 4GB. This means our figures will be slightly faster than those you'll achieve from a retail machine.

Luckily, this doesn't affect its biggest selling point: battery life. Lasting almost 14 hours of light use and more than eight hours under heavy load, the ES1-111M keeps going when most other laptops – of any price – start to falter. It isn't consistently good enough to win an award, but it's still worth considering if all-day stamina is a priority.

RIGHT The majority of the connectivity options sit at the rear of the laptop





Asus X200MA

A generous amount of storage on offer – but elsewhere, the X200MA is lacking

SCORE ★★★★

PRICE £167 (£200 inc VAT) from pcworld.co.uk (pcpro.link/248x200ma)

While the Asus X200MA is more expensive than its stablemate, the EeeBook X205TA (see p92), the extra £25 nets you a better specification and more local storage, albeit at the expense of portability and battery life.

Our review sample arrived in a business-like black, but the X200MA is also available in snazzy red, blue and white finishes. There's some flair in the dimpled texture on the keyboard surround and the lid, and the curvy, wedge-like profile provides a good typing position. You can see signs of the X200MA's price in the lightweight plastics, but it still feels noticeably tougher than the EeeBook.

On the downside, it's larger: 16mm wider, 7mm deeper and more than 25mm thick at the rear of the machine. That translates to a weight of 1.24kg – still light, but not as ultra-light as the X205TA.

Connectivity is good, too. You'll find VGA and full-sized HDMI ports on

ABOVE The wedge-like profile of the X200MA, with its deeper rear, provides a good typing position

the left, along with a USB 3 port, while two USB 2 ports and an SD slot sit on the right. Asus has also squeezed in an Ethernet port with an ingenious expanding opening, though: it supports only the 10/100 standard.

The display is a mixed bag. On one hand, the X200MA does a better job of handling darker tones than the EeeBook or the Acer Aspire ES1-111M, and its 492:1 contrast is pretty good. On the other, its brightness levels max out at a relatively dim 200cd/m². In practice, this wasn't an issue indoors, but in brighter conditions the picture looks washed out.

Audio is comparatively good, with Asus' SonicMaster speakers putting

out a sound with richer tone, better clarity and more stereo width than the competition. It's too brash, bass-light and mid-range-heavy for any serious entertainment, though.

Asus scores additional points for the touchpad: it's a good size, and responsive too. However, marks are lost for the keyboard: a very light, shallow action makes it difficult to tell whether or not you've hit a key.

The X200MA's non-removable, three-cell, 3,300mAh lithium-ion battery doesn't hold up well against the competition. It gave out short of six hours in our light-use test, and lasted fewer than five hours in our more demanding heavy-use test.

Where the EeeBook is held back by its Bay Trail-T Atom processor, the X200MA uses a faster Celeron N2830. While they're both based on Intel's Silvermont microarchitecture, the EeeBook's quad-core Atom Z3735F is limited to 1.33GHz, hitting 1.83GHz in burst mode; the dual-core Celeron N2830 starts at 2.16GHz and can go up to 2.41GHz.

Unfortunately for Asus, its competitors are using the dual-core Celeron N2840 in their laptops, which boosts higher to 2.58GHz, and has a faster graphics core. As a result, the X200MA still struggles to keep up with its rivals in our benchmarks.

Overall, this is a decent laptop for the money, and with 500GB of local storage, it's a tempting proposition. If you're happy working in the cloud, however, the HP is the better choice.



RIGHT Asus includes 500GB of local storage and both VGA and HDMI ports



Toshiba Chromebook 2 CB30-B-104

Toshiba's latest Chromebook outperforms every other similarly priced laptop in this group

SCORE ★★★★☆

PRICE £225 (£270 inc VAT) from johnlewis.com (pcpro.link/248toshch)

It's no secret that the new Windows 8.1 with Bing laptops are a reaction to Google's cut-price, cloud-based Chromebooks, and devices such as the Toshiba Satellite CL10-B and HP Stream 11 make a compelling case for Microsoft's initiative. Does this mean curtains for the Chromebook, or has Google got an equally strong reply?

It has, in the shape of the Toshiba Chromebook 2 CB30-B-104. It's more expensive than the Windows 8.1 with Bing laptops, at £270 for the premium 13.3in model, but it's easily the best Chromebook yet.

The big news is the display. It's an IPS panel with a Full HD 1080p resolution – practically unheard of in Windows laptops costing less than £500. It's bright, at 357cd/m², and has an equally impressive contrast level of 839:1. With an average Delta E of just 3.43, colours are reasonably accurate, and it covers 88.6% of the sRGB gamut.

ABOVE The IPS display with Full HD resolution pushes the Chromebook ahead of the pack



In this test it blows every other display out of the water.

Otherwise, the core specification is fairly run of the mill, with a dual-core Celeron N2840 running at 2.16GHz, 4GB of RAM and a 16GB eMMC flash drive. Although that's stingy on the storage front, bear in mind that Chrome OS uses local storage merely to cache files rather than holding them permanently, with most applications running from and storing data in the cloud.

The very nature of Chrome OS makes apples-to-apples comparisons difficult, but we ran the Peacekeeper and SunSpider browser benchmarks across all this month's laptops and

the CB30-B-104 was faster than anything else on test: a score of 1,690 in Peacekeeper left Windows rivals in the dust. Fire up Google's office apps or Office Online and getting your work done will be a breeze. The keyboard suffers from a slightly spongy action, but it's spacious and well laid out and the touchpad is large and responsive.

Just bear in mind that, while Chrome OS is highly efficient when it comes to running web-based apps, more demanding video- or image-editing apps, not to mention games, will be more problematic.

Connectivity options are basic, too, with one USB 2 port and an SD slot on the left side and only one USB 3 port on the right. With no Ethernet, you're limited to dual-band 802.11n Wi-Fi and Bluetooth for speakers and peripherals. Elsewhere, the Skullcandy-branded speakers are weak at the low-end, giving drums a dustbin-lid effect, and vocals sound terribly insubstantial.

While Chrome OS is no longer hostage to a stable web connection, there's no question that a Chromebook isn't as flexible as a Windows 8.1 with Bing device; using Windows, Office 365 and OneDrive feels more seamless. Yet, if you're happy to spend most of your time using online apps, it's impossible to find a better laptop for this money. A similar model, the CB30-B-103, comes without the Full HD screen and only 2GB of RAM for £189, but we'd say this machine is well worth paying the extra for.

RIGHT The keyboard is spacious and well laid out, and all the basic connectivity options are present





Toshiba Satellite CL10-B

An attractive, low-cost Windows laptop, but the CL10-B can't quite keep up with the best here

SCORE ★★★★

PRICE £167 (£200 inc VAT) from argos.co.uk (pcpro.link/248toshsat)

The Toshiba Satellite CL10-B was the first Windows 8.1 with Bing device we looked at, and we were impressed by its smart design, reasonable performance and decent screen. Now that it's been joined by a new breed of low-cost laptop, can it still stand up as one of the best?

It's certainly one of the most attractive. Toshiba has used its Chromebook experience as the basis for the CL10-B, and while it still looks a little like an imitation Ultrabook, its plastics feel thicker and its construction more solid than similarly priced rivals. It's a thoughtful design, too, with the weight concentrated in the base to provide balance, a textured underside that doesn't slip around much on the lap, and a lid that raises the body of the laptop off the desk as you push it backwards, giving you a better angle for typing.

With a maximum luminance of 260cd/m², the CL10-B doesn't have

ABOVE Office 365 and 100GB of cloud storage are included in the price of the CL10-B

the brightest screen on test, and colours aren't accurate enough for image-editing purposes. That said, there's plenty of clarity and contrast, and colours are vibrant without looking over-egged. Sadly, sound is right down there with the worst. The speakers produce a tinny output that would disgrace a 1980s pocket radio, and the louder it gets, the harsher and more distorted it becomes.

There's nothing much wrong with the layout of the keyboard, but the individual keys are small, the cursors and function keys are tiny,

and the spacebar is frustratingly undersized. The keys are lacking a touch in terms of travel too, and the action is distinctly lacklustre. By budget laptop standards, though, it isn't the worst we've tried. We could work on the CL10-B; we're not sure we could say the same about the Acer Aspire ES1-111M.

The core specification is the same as the HP Stream 11 and the UK retail version of the ES1-111M: that means a dual-core Celeron N2840, based on Intel's Bay Trail-M architecture, plus 2GB of RAM. In terms of speed, the Toshiba sits between the HP and the Acer, and feels as snappy in everyday use. Provided you're not planning to edit video, play console-quality games or process raw photos from your DSLR, you won't have any day-to-day complaints.

Like those two laptops, the CL10-B is constrained when it comes to storage, with only 16.8GB available of its 32GB storage. However, with Office 365 and 100GB of cloud storage for two years, it's hard to complain. Unfortunately, battery life is another matter; in both our light- and heavy-use tests, the CL10-B gave up the ghost before the HP Stream, and long before Asus' EeeBook ran out of steam.

While the Toshiba Satellite CL10-B remains one of the more enticing low-cost laptops around, it can't match the HP Stream on performance, battery life or price.

RIGHT The CL10-B is an attractive laptop, with a more solid construction than its rivals





Asus EeeBook X205TA

Cheap and light – but poor performance and connectivity options put it out of the running

SCORE ★★★★☆

PRICE £146 (£175 inc VAT) from laptopsdirect.co.uk (pcpro.link/248eeebook)

There's definitely something of the netbook in the new breed of Windows 8.1 with Bing devices, so it's fitting that Asus has revived the EeeBook brand with its example. It looks surprisingly glamorous, with a matte champagne finish applied to all the plastics bar the keyboard and the frame around the screen.

The feel isn't quite so luxurious, though. While the base seems solid, the screen is flexible and flimsy. Still, at 18mm thick and weighing 950g, the EeeBook is the thinnest and lightest laptop on test.

The 11.6in, 1,366 x 768 display is a big step up from what we used to see



on netbooks. It's bright, hitting a maximum of 288cd/m², and the 414:1 contrast level is great too.

Unfortunately, it falls down when it comes to the depth and richness of its colours; the display gamut covers only 55% of the sRGB standard. The speakers are just as bad: very bright,

Below With only two USB 2 ports and microSD and HDMI, connectivity is restrictive



twice as brash and, frankly, uncomfortable to listen to.

Corners have also been cut on connectivity, with only two USB 2 ports and no USB 3. Asus has also opted for both microSD slot and micro-HDMI connectors when full-sized versions would be more useful. Storage is lacking, too, with only 16.9GB of space available once Windows, Asus' apps and the recovery partition have had their share – although this is less of an issue with a cloud-focused machine. One year's subscription to Office 365 Personal with 1TB of storage is included.

The X205TA's biggest issue is performance. Its CPU is a Bay Trail-T Atom Z3735F processor with four cores running at 1.33GHz, which just can't keep up with the faster Celeron systems. You'll find performance adequate for surfing the web or working on a Word document, but this isn't as powerful or versatile a laptop as the similarly priced HP Stream 11 or Acer Aspire ES1-111M.

On the plus side, battery life is superb, lasting more than 14 hours in our light-use test. Even here, though, the Acer isn't far behind. Such strong competition makes the Asus EeeBook X205TA hard to recommend.

Lenovo B50-30

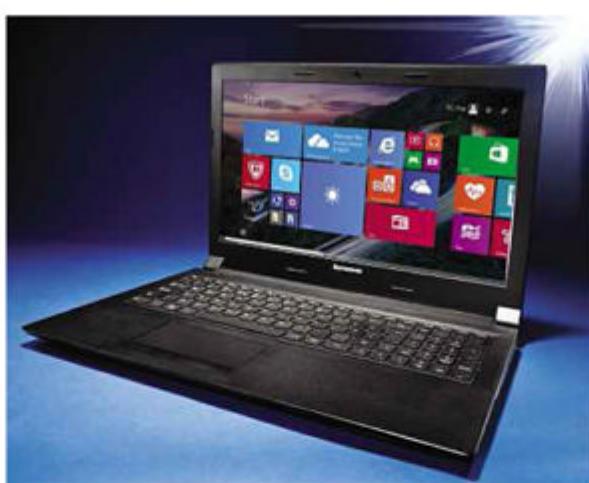
Plenty of laptop for the money – including generous storage – but too little of it is any good

SCORE ★★★★☆

PRICE £142 (£170 inc VAT) from ebuyer.com (pcpro.link/248lenB5030)

Whereas most sub-£200 budget laptops provide 11.6in screens, Lenovo has decided to go big with the B50-30, delivering a slightly old-school laptop with a 15.6in screen and a built-in DVD writer. At 2.32kg, it's substantially heavier than the other models here; while the manufacturer has done its best to slim down the laptop's bulk, the B50-30 is still a beast to lug around.

Build quality is disappointing by Lenovo's standards. The plastics feel thin, the lid flexes alarmingly when twisted, and there's too much give near the DVD-writer tray. The B50-30 is noisy, too, thanks to a 500GB, 5,400rpm hard disk that clatters away at the slightest provocation.



On the plus side, this means more local storage than you get from most slimline rivals. The B50-30 doesn't do badly for connectivity, either: it has VGA and HDMI video outputs, three USB ports, including one USB 3, and a single Gigabit Ethernet port. There's also 802.11n Wi-Fi and Bluetooth 4 for wireless networking. It's a laptop that's ready for anything.

Below Bigger build allows more room for ports



The screen's one advantage is its size; otherwise, it's poor. We measured brightness and contrast levels at a lowly 209cd/m² and 285:1 respectively, and in use the display has a dull, grainy look to it. We don't expect superb colour accuracy from a budget laptop, but the B50-30 covers a mere 59.7% of the sRGB gamut, and it struggles to differentiate dark colours or resolve blues with any kind of vibrancy.

Keyboards are usually a Lenovo strength, but while the B50-30's looks the part, with large keys and a standard business layout, the typing action is strangely floppy. Typing on it feels like drumming your fingers on a wet jiffy bag. The touchpad is better – it's large, smooth to the touch and accurate.

Performance isn't bad by budget laptop standards; the B50-30 has the same Celeron N2840 as the Labs-winning HP Stream 11, and while the hard disk slows it down a little, it isn't too far behind in our benchmarks.

Battery life is another matter, though. The Lenovo could only survive four-and-a-half hours of light use, and a little over four hours with heavy workloads. It's a versatile machine for the money, but the B50-30 isn't the most well-balanced laptop around.

View from the Labs

Windows 8.1 with Bing or Chrome OS? **Stuart Andrews** finds that, for those seeking an affordable laptop, there are choices aplenty

With this new breed of budget laptops, the PC industry is finally delivering what the netbook always promised: an affordable, lightweight computer that's ideal for everyday tasks. For a while, it might have seemed there was no need for such a thing; tablets are cheap, speedy and versatile, and you can always add a keyboard if you need to type. But anyone who has tried to get serious work done on a basic tablet will know that sometimes you pine for a proper keyboard that doesn't flap around on your lap, a screen that stays up of its own accord, and a way of selecting tools or tapping on a web page that always gets you the result you're looking for. In these respects, the new budget laptops have their tablet brethren beat.

We've been impressed by how functional these devices are. Sure, put the HP Stream 11 next to a MacBook Air and there's absolutely no comparison, but in isolation it has a perfectly decent screen, an effective keyboard and more than adequate battery life. The same goes for the Toshiba Satellite CL10-B and the Acer Aspire ES1-111M. As a journalist, I wouldn't want to use any of them



Stuart Andrews is a regular contributor and former PC Pro reviews editor

all day, every day as a work machine, but as a laptop for light browsing or drafting features when out and about, they're fine. It's not hard to see these laptops making it big with students and schoolkids. They might even attract small businesses, which might not need a big, high-resolution screen or serious horsepower, but are instead looking for a functional PC that doesn't cost too much. They're not rugged or reliable enough for life on the road with a mobile sales team, but as a PC for handling emails and documents?

No problem.

Should you buy one over a Chromebook? Here things become tricky. The odd thing about Windows 8.1 with Bing is how unrestrictive it is.

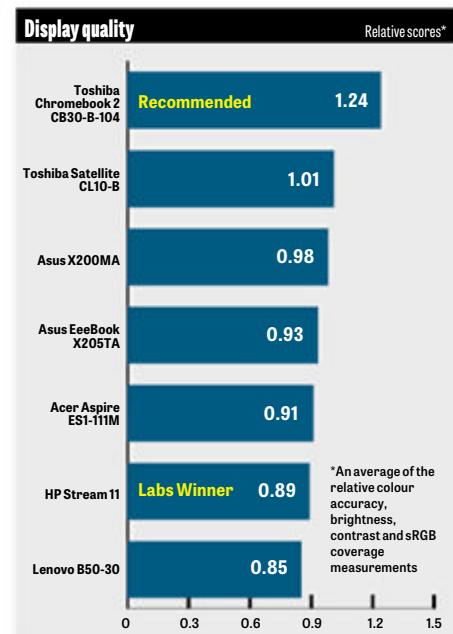
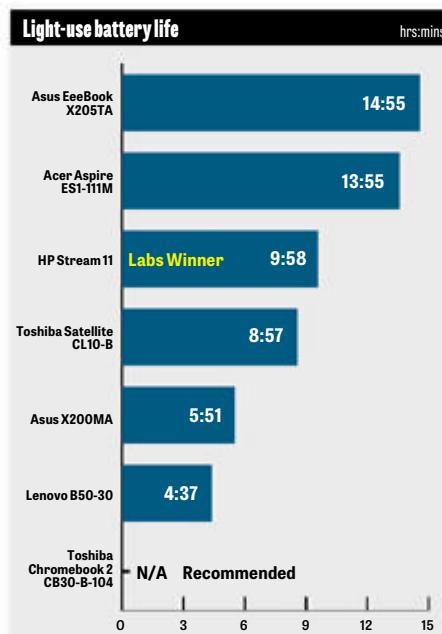
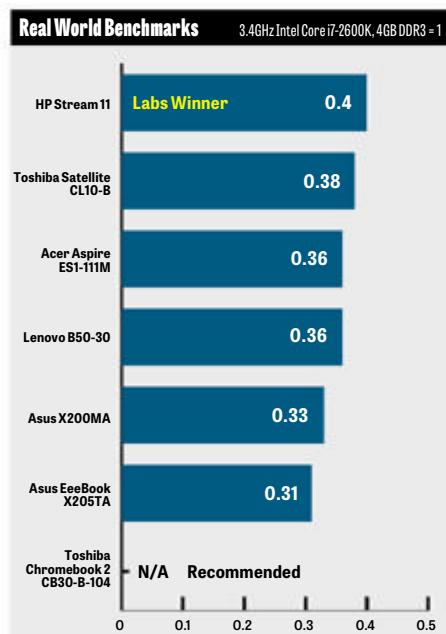
Beyond the promotion of Microsoft's web services, it doesn't come with any limitations versus standard Windows 8.1, and while the manufacturers have cut costs by minimising storage, there's no reason why you can't plug in a cheap USB 3 drive when you're at your desk. This, and the

"It's not hard to see these laptops making it big with students and schoolkids; they might even attract small businesses"



option to install more applications locally, makes the Windows laptops more versatile than the average Chromebook. All the same, if you're happy with web-based applications – including Office Online – then Chrome OS tends to be snappier, more efficient and easier to maintain. For many Windows users, a move to a budget Windows 8.1 with Bing laptop couldn't be easier, but don't write off the Chromebook: it can be a highly effective tool and – as the Toshiba CB30-B-104 shows – incredibly good value for money. ●

Test results



The Network



Practical buying and strategic advice for IT managers and decision makers

Business Focus

Keep an eye on your network with the right software p94

The Business Question

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Cheat Sheet

Upgrade your business broadband p108

BUSINESS FOCUS

Choose the right monitoring software for your network

Find yourself firefighting network problems? Dave Mitchell explains how to regain control by investing in network-monitoring software



Downtime is a dirty word for today's busy networks. To forestall howls of complaint from end users, support staff need to be able to spot faults and rectify them in double-quick time – and to do this they need network-monitoring software.

In the past only affordable for enterprises with deep pockets, many monitoring products are now priced right for smaller businesses as well. In this month's buyer's guide, we look at four of the best software solutions on the market, reveal their key features and explain how to make your choice.

The screenshot shows the SolarWinds Discovery Center interface. It includes sections for Network Discovery (showing 2580 devices discovered), Interface Discovery (showing 187 interfaces), and Virtual System Discovery. The main pane displays a 'Devices Discovered' table with columns for Host Name, Address, Brand, Model, and Operating System. A progress bar at the bottom indicates the discovery process is 95% complete.

BELOW All products run automatic discovery routines to find out what's on your network

Voyage of discovery

You don't need to tell network-monitoring software what's on your network – it will do this for you. Just provide the IP address ranges you want the software to peer into, along with the relevant credentials, and it will run a discovery process.

You may be surprised at what you find. For example, we discovered a network switch in our rack that was running but not being used, and a NAS appliance we'd thought had been powered off days ago. We were also alerted to a couple of servers that, although not running, still had active IPMI (intelligent platform management interface) connections so could easily be remotely accessed and switched on.

After a discovery is complete, the monitoring software should categorise devices into groups for easier management and identification. SolarWinds, for example, is able to group systems by OS and vendor, allowing you to see at a glance what types of systems and devices are present on the network. In contrast, Paessler just lists everything it discovers – but it does then let you arrange hosts into custom groups for easier identification.



Analyse this!

The sheer volume of traffic and apps on a typical modern network means the software has a lot to do. Along with diagnosing connectivity issues, it should tell you how your servers are handling the load, what your messaging apps are up to, and whether your websites are singing and dancing.

The good news is that all four products can do this and plenty more besides. At their foundation, they'll keep you posted on hardware and system health, but they're also aware of a wide range of apps including Hyper-V, VMware, Active Directory, Exchange, IIS and SQL Server. ManageEngine and Ipswitch offer the best app-monitoring tools, but you pay for the privilege as their application performance management (APM) plugins are optional. Paessler provides more basic app-monitoring functions, but these are included as standard.

Licensing – sensor, element or device?

It's important to look into the various licensing schemes on order to control costs. Paessler is the easiest to understand: you simply buy blocks of sensors. Do the maths first, though, as the sensor count mounts up quickly. For example, our 48-port HP ProCurve switch grabbed 66 and our Exchange server took another 63. Still, we could control usage by deleting those we didn't want.

Both Ipswitch and ManageEngine initially look more expensive, but licensing is per device. In our example, the HP switch and Exchange server would use only two licences.

SolarWinds is the most complex, since it licenses its software by a combination of node, interface and disk volume. With an SL250 licence, you receive a total of 750 elements, but if any one of them goes over the 250 count you must upgrade to the next level; a video on the company's website (solarwinds.com) provides an explanation.

You're on your own

Systems must be correctly configured prior to monitoring, but few vendors provide tutorials on how to do this. For Windows systems, the Windows Management Instrumentation (WMI) service provides more information than SNMP – including details on storage utilisation and apps such as Hyper-V – and is installed by default.

However, WMI has higher overheads, with a poll using around



LEFT Paessler's iOS mobile app is the best of the bunch – and it's free

Monitoring on the move

Network-monitoring software now extends its reach beyond the static network in your buildings. In our selection, Paessler stands out since it provides free apps for iOS and Android devices. They're easy to use, connecting to the central PRTG server, and provide a similar monitoring interface.

ManageEngine has its free OpManager iPad app, which isn't as informative but does provide a good overview of monitored systems. The Premium version costs an extra £40 and adds interactive alarms and workflow-configuration tools.

"It's important to look into the various licensing schemes of software packages in order to control costs"

WhatsUp Gold's Mobile Access service provides browsers on mobile devices, with a small subset of features on the host. SolarWinds has its Mobile Admin tool, which must be installed on a Windows Server host and links to devices running the Mobile Admin Client; it costs £460 for four users.

What's on your network?

If support departments don't know what's on their network, then they can't possibly manage it properly; networks have a habit of growing exponentially and before you know it, they're out of control.

Network-monitoring software can inform you what's out there and put control firmly back in your hands. All four products in this buyer's guide provide a wealth of information, so turn the page to see which one will help you to keep your eye on the ball.

BELLOW It's optional, but Ipswitch's WhatsVirtual is the only product that lets you control your VMware VMs





Ipswich WhatsUp Gold Premium v16.2

Optional plugins can inflate the price, but WhatsUp Gold can't be faulted for its monitoring capabilities

SCORE

PRICE 100 devices, £2,470 exc VAT from whatsupgold.com

Ipswich has worked hard to make WhatsUp Gold easy to use, and this can be seen in its slick dashboard. We found it simple to customise views in order to keep an eye on all our critical systems and find out the moment any went AWOL.

A ribbon menu across the top of the web console provides swift access to all features, while in-context navigation means a monitored device stays selected regardless of the view or menu option selected. Views are modified easily from the built-in designer tool and its lightbox, which is useful for previewing different views and graph styles.

The Standard edition (starting at £1,198) provides device discovery, mapping, SNMP monitoring, alerting and reporting. You can add a number of optional components, but to get WMI and wireless monitoring you'll need the Premium version on review.

WhatsUp Gold took less than 30 minutes to install on a Windows Server 2012 R2 host, and a quick-start wizard took care of scheduling network discoveries. It's fast, too, with an SNMP smart scan of our lab subnet taking only two minutes. Using Device Roles, we applied



predefined sets of passive, active and performance monitors, plus actions and alerts to each system class.

After importing discovered devices into the software, we moved over to WhatsUp Gold's main web console, where the homepage opens with a quick-start guide. This can be customised: options include bar charts for systems with the highest interface, disk, CPU and memory utilisation, tables of downed devices, active alerts, reports and more.

Hovering the mouse pointer over a system in the Devices view loads a pop-up showing performance and active monitors, plus WhatsUp Gold group membership. It contains hyperlinks, too, so you can quickly access the monitors shown.

All WhatsUp Gold components are accessed from the top menu and we found it easy to switch from, say, the Device or Alerts view to reports, logs or inventory. For the latter, WhatsUp Gold accurately identified the CPUs in

ABOVE WhatsUp Gold's informative web console is easy to customise and kept us in touch with all the action

our systems; it didn't link this data to the system-utilisation monitors, however, which always showed the CPUs as "unknown".

Wireless network monitoring presents dynamic maps showing access points (APs) with their associated clients, and you can drill down to see lists and graphs of SSIDs, signal strength and signal-to-noise ratios. It's great for keeping an eye on BYOD users, but it only supports APs from Cisco, Aruba, Meru and Ruckus.

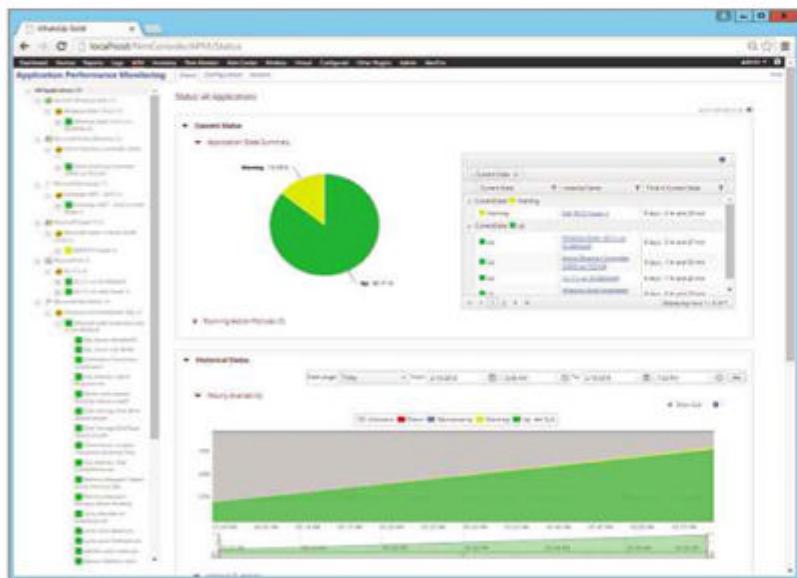
The WhatsVirtual plugin is handy for VMware. We used it to monitor our ESXi host resources, view all VMs, see their status plus virtual resource usage and link active or passive monitors to them.

Historically, the lack of Hyper-V monitoring has been a pain, but WhatsUp Gold can achieve this via the application-performance monitor (APM), available with the Premium edition. APM profiles define the applications or components to be monitored and actions to be taken if thresholds are breached.

Using predefined profiles, we created monitors for our Hyper-V system, Exchange, SQL Server, Active Directory and the WhatsUp Gold host itself. We could monitor all key application attributes and assign actions for sending email or SMS alerts, running PowerShell scripts or restarting a service.

The optional plugins increase costs significantly, but there's little on the network that WhatsUpGold can't monitor. It's a pleasure to use.

REQUIREMENTS Windows Server 2003+ Options: APM, from £1,140 exc VAT; WhatsVirtual, £1,697 exc VAT



"WhatsUp Gold took less than 30 minutes to install, and an SNMP smart scan of our lab subnet took only two minutes"

LEFT Ipswich's optional APM plugin provides a wealth of information



ManageEngine OpManager 11.5

The new UI needs refining, but OpManager scores highly for slick monitoring and good value

SCORE ★★★★☆

PRICE 50 devices, £1,298 exc VAT
from manageengine.com

ManageEngine's OpManager 11.5 is in the process of migrating to a swish API-driven user interface, but if it's not to your liking you can easily switch back to the older web console. And we did, because we found the discovery process in the API client awkward to set up – and when we did get it going, it missed a few of our lab systems.

Neither console would allow us to include the root credentials for our VMware host in a standard sweep, so it had to be added manually as a separate device. Even so, after a couple of attempts we had all our systems correctly discovered and proceeded to be amazed by the sheer range of features on offer.

Both UIs open with network overviews, brimming with colour-coded icons and graphs providing at-a-glance views of device status, highest disk usage, alerts, the top-ten issues and much more. Multiple dashboards with a choice selection



of widgets can be created and customised at will; you can even integrate Google Maps into them.

The API client also includes a handy heatmap widget: a grid of coloured blocks representing each system and their status. Hover the mouse over a block and a small pop-up box displays the associated system, while clicking on it takes you straight to its vital signs.

OpManager provided plenty of data on our VMware and Hyper-V hosts. All standard OpManager system-monitoring functions are available, so we could keep a close eye on host and VM performance plus interface, CPU, memory and disk utilisation.

All VMs for each host were listed, along with their running status. We added more monitors to selected VMs to watch Windows services,

ABOVE OpManager's new API-driven interface has some rough edges, but it's very informative

"Multiple dashboards with a choice selection of widgets can be created at will: you can even integrate Google Maps into them"

BETWEEN The new APM plugin let us monitor the bucket list for our Amazon S3 account

URLs and processes, and linked them with monitoring intervals, thresholds and notification profiles.

Snapshots for both physical and virtual servers provide quick views of a device's health, availability and alerts. The CCTV view also proved useful: we grouped all the top-ten issues in one view so we could immediately see where problems were occurring.

OpManager also spotted Exchange on our mail server and added an extra tab in the API console with details on information store, POP3 and SMTP activity. We found more detail for Exchange in the old UI, since it also showed transport responses, queue lengths and service status, plus OWA user counts and requests.

Only currently accessible from the old GUI, the new application performance management (APM) plugin supports more than 70 apps out of the box and even includes monitors for cloud services.

ManageEngine includes five app monitors for free, and we swiftly created ones for Exchange and our Amazon S3 cloud account so we could check on availability, downtime and associated storage buckets.

OpManagers' workflows take the strain out of general network maintenance and troubleshooting. These define sequences of conditions and actions such as restarting a service, copying a file or rebooting a VM, and are easy to create: the process is entirely drag-and-drop.

Workflow categories include systems, processes, HTTP and FTP, files, folders, VMware and OpManager itself. Each category contains a set of checks and associated actions, so we just picked the icons we wanted, dragged them into the workflow-design page, customised their values and arranged them in the desired running order.

The new API client interface is currently a work in progress, and will need improving before we'll forsake the older UI. That said, OpManager is capable of providing a wealth of information about network and system performance, making it simple to troubleshoot problems.

Bucket Name	Bucket Size (MB)	Bucket Location	Creation Date	Virtual Folders	Number of Objects	Health	Configure Alarms
binarytesting3	0	EU	Thu Sep 19 16:45:43 BST 2013	1	0	Green	Configure
binarytesting2	0	eu-west-1	Thu Sep 19 16:43:34 BST 2013	1	0	Green	Configure
binarytesting1	0	eu-west-1	Thu Sep 19 15:28:00 BST 2013	1	0	Green	Configure

REQUIREMENTS Windows 7,
Windows Server 2003+



Paessler PRTG Network Monitor 15

A simple pricing structure, no hidden costs and a heap of monitoring sensors make this our A-List choice

SCORE

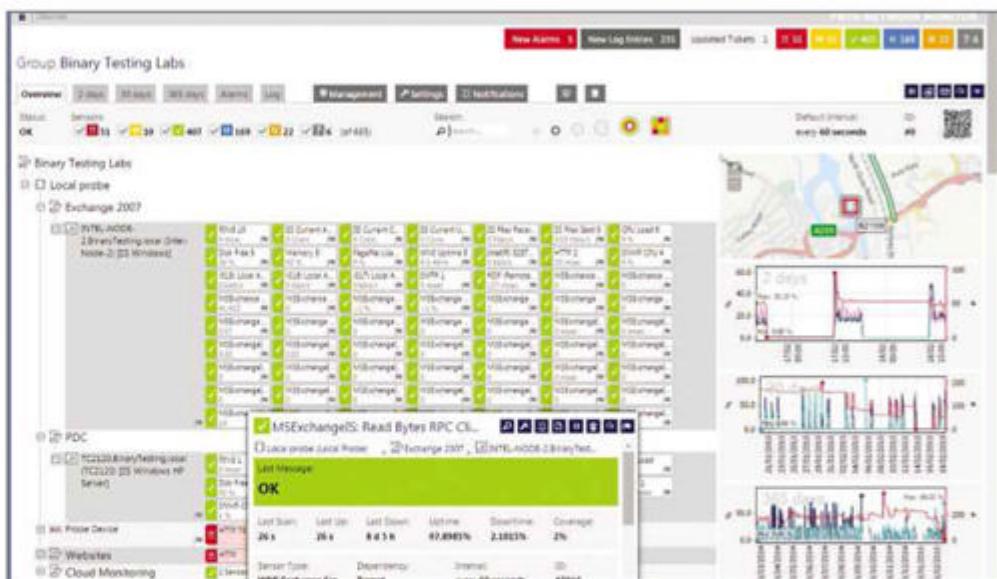
PRICE 500 sensors, 1yr maintenance, £885 exc VAT from paessler.com

There's one excellent reason to go with Paessler's PRTG Network Monitor 15: it has no hidden costs. Switches, routers, Windows servers, workstations, critical apps, VMware, Hyper-V – they're all included in the price.

In addition, licensing is based purely on sensor count, so you only pay for what you want to monitor. That said, we found that sensors can get used up quickly. After running our first discovery on the lab network, PRTG swallowed up more than 300, with our 48-port HP ProCurve Gigabit switch alone using 66. Clearly, these needed culling, but that's easy enough to do: from the main dashboard, we simply deleted those we didn't want and returned them to our sensor pool for use elsewhere.

The PRTG web console has been redesigned with a focus on performance. The move to HTML5 and Ajax works well: we found page reloads were faster than those in SolarWinds and Ispwich, perhaps because it only refreshes elements rather than the whole page.

New users will approve of the Configuration Guru, which helps



get your first network discovery running. Set aside a bit of time, though: we found it took more than an hour just for our lab network. PRTG selects a base set of sensors for each system as they're discovered, and adds them to the dashboard.

The dashboard can get busy, but we kept it in order by using Paessler's hierarchical grouping feature. As we moved systems, they inherited settings such as login credentials and discovery schedules from their parent group, which we then customised as required.

The sensors are colour-coded so you can see at a glance which are up, down, paused or in a warning state. Hovering the mouse pointer over a sensor causes a live view graph to pop up; select one and drill down for more information.

Data is easily filtered from the dashboard's sensor tabs; we pulled up views of the top-ten sensors for uptime, downtime, CPU usage, fastest website responses and more. PRTG uses sensor state and threshold

ABOVE The PRTG interface gets busy quickly, but we tidied it up by creating groups for different systems and services

triggers to send out email, SNMP trap, SMS and syslog alerts, and these values can be set at any level of the group hierarchy.

Mobile users will love Paessler's free apps, too, since they can remotely access the PRTG server and display sensor data. With the iOS app loaded on our iPad 4, we connected to the core PRTG server, pulled up sensor data on monitored systems, remotely accessed its central reports and received push notifications when sensor thresholds were breached.

Few devices will escape PRTG's gaze: it includes more than 150 sensor types, ranging from SNMP and WMI to databases, mail servers and Exchange. It also found our Netgear WNDAP350 wireless controller and added SNMP traffic sensors for all its active virtual access points (APs); however, we found it couldn't report on the number of wireless clients on each AP.

PRTG also found our VMware and Hyper-V hosts and automatically assigned sensors to each VM, allowing us to keep an eye on their virtual resource usage. Currently in beta, the IPMI sensor worked fine with our Broadberry,

Dell and Lenovo servers, where it displayed graphs for fan speeds, voltages and temperatures.

Paessler's PRTG Network Monitor 15 delivers a slick set of network-monitoring tools neatly amalgamated into a single console. You'll need to keep a close eye on sensor usage, but the fact that it will monitor just about anything straight from the box, without the need for any expensive add-ons, makes it a worthy entry on our A-List.

"Mobile users will love Paessler's free apps, since they can remotely access the PRTG server and display sensor data"

LEFT PRTG's web console can show a complete overview of all your systems and their current status



REQUIREMENTS Windows 7, Windows Server 2008 R2+

Looking for work/life balance? Office 365

If you're lucky enough to watch the Grand Prix live in Monaco or like the rest of us will be watching it on a screen, a few hours of downtime to enjoy the race isn't beyond your reach if you've got access to everything you need.

Did you know that with **Office 365** you can work **anytime, anywhere, on any device?**

With immediate access to your familiar Office tools, combined with Exchange email, Skype for business and an array of other productivity apps, whether in front of the flat screen or in the pits - you can stay in touch wherever you are.

Access your office in less than a lap time with Office 365 – and don't miss a second of the Monaco action.

To find out more, call us on

0845 122 4333

or email letschat@eclipse.net.uk

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SolarWinds Orion NPM 11.5

Plenty of features on offer for your money, all presented in a well-designed web console

SCORE 

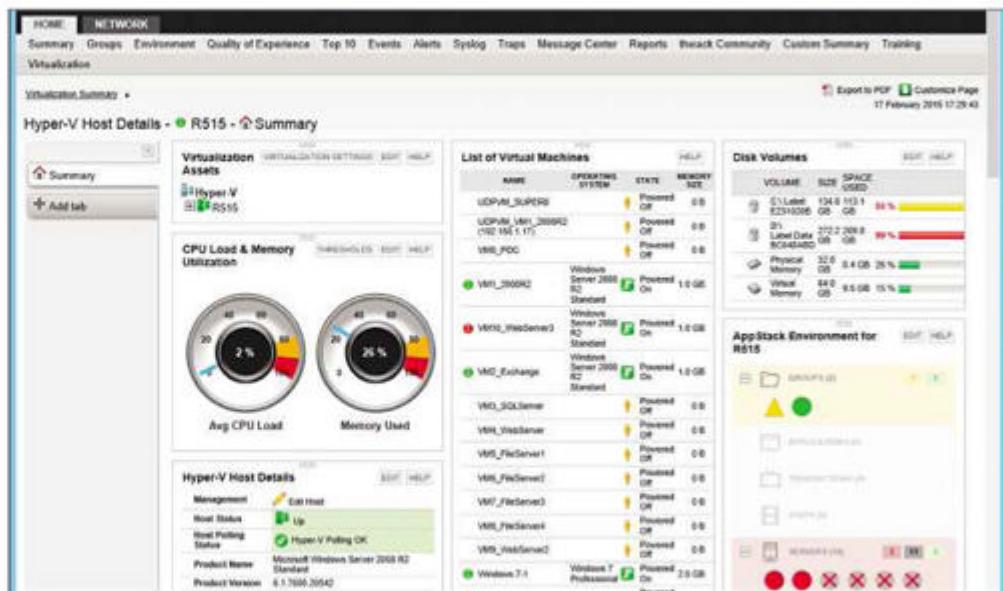
**PRICE 250 elements, £3,880 exc VAT
from solarwinds.com**

One reason we love the latest version of SolarWinds' Orion Network Performance Monitor (NPM) is the sheer number of features it packs in as standard. They include support for 802.11 wireless access points (APs), VMware and Hyper-V hosts, and a handy QoE (quality of experience) tool for monitoring app traffic.

Even better, NPM's LUCID ("logical, usable, customisable, interactive and drill-down") UI lives up to its name. Its homepage presents a summary of network activity, device status and alerts, which allowed us to quickly identify problems.

You can customise each view to your own requirements: we swiftly added new columns, resized them to fit and moved monitored resources within columns. What's more, the NPM discovery took only ten minutes to scan the lab's subnet. Discoveries can be scheduled to run regularly and set to alert you when changes occur or new devices are detected.

Fault diagnosis is equally fast. We simply selected devices in alert states from the summary page and drilled



down for more detail. The amount of information available for each device is staggering: the network topology views for our HP switches revealed which systems were physically connected to each port.

NPM alerts range from sending emails to running scripts or other programs. They can be linked to individual devices and dynamic groups, while conditional group dependencies stop alert flare-ups occurring when a core device fails.

Once NPM has enough historical data to work with, it can provide forecasts for capacity planning. We didn't need to do anything to activate this, either, as the drill-down display for our servers included forecast graphs for physical and virtual CPU and memory resources.

NPM spotted our VMware host without problem, allowing us to view its vitals and all VMs from the Virtualization pane. Our Hyper-V

ABOVE NPM's central console provides native support for VMware and Hyper-V hosts

system had to be added using WMI/ICMP, though, as a straight SNMP discovery wouldn't identify it. With this sorted, it now appeared in the same pane as our VMware host, along with all VM and host utilisation details. For a greater insight into virtual environments, we recommend the optional Virtualization Manager - prices start at £1,975.

NPM identified our Netgear WNDAP350 wireless controller and showed all its virtual APs along with interface utilisation and throughput. We're a little disappointed that it couldn't list wireless clients, though, and the heatmap feature only works with Aruba, Cisco, HP, Meru, Ruckus and Motorola APs.

To test QoE, we deployed the packet-analysis sensor on the NPM host and connected it to a mirror port

“NPM had no problem spotting our VM host, allowing us to view its vitals and all VMs from the Virtualization pane”

The sensor categorises network traffic into more than 1,000 predefined apps, and we were bowled over by the level of detail on offer: HTTP, HTTPS, CIFS, FTP, Exchange, SQL, Facebook and Amazon Web Services were all picked up. We were able to monitor details such as app response times, and also found it useful that QoE separated traffic into graphs showing business, social and potentially risky categories.

The licensing structure is a little confusing, but SolarWinds NPM 11.5 delivers a wealth of new features, including excellent monitoring for virtualised environments – and it's a cinch to customise.



LEFT The QoE plugin monitors all network traffic and separates it into meaningful graphs and charts

REQUIREMENTS Windows Server 2003+



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IDrive Online Backup for Business

A brilliant backup choice for business – IDrive offers all the features you could want for a remarkably good price

SCORE

PRICE 250GB, £65/year exc VAT from idrive.com

In our recent cloud-backup buyers' guide (see issue 243, p98), we described MozyPro as affordable, offering as it does 50GB of storage for £209 exc VAT. Well, IDrive Online Backup for Business blows it clean out of the water for value. A starting price of £65 per year buys you 250GB of cloud storage, unlimited servers and workstations and support for business apps including Exchange, SQL Server and SharePoint.

IDrive also provides Dropbox-like sync services, and the fee includes an equal amount of sync space. Plus, both continuous data protection (CDP) and disk image backup are included, while IDrive matches MozyPro's 2xProtect feature by securing data to a local drive or network share for fast recovery.

To load the IDrive client, we logged on to our portal from each system and downloaded it; there are no email deployment tools. IDrive uses AES-256 encryption and you can either use a default key or specify your own. Don't lose it: for extra security, the key isn't stored on the cloud servers.

The client starts with a default backup set for common files and documents and creates a unique cloud

The screenshot shows the 'Advanced backup / restore' section of the IDrive web interface. It lists several backup types:

- MS SQL Server:** Supports full and transaction log style backup using SQL Server API technology.
- MS Exchange Server:** Supports Exchange Server disaster recovery.
- Exchange Brick Level:** Allows backup / restore individual Mailboxes without interrupting the running MS Exchange Server services.
- MS SharePoint Server:** Backups entire sites or a specific site, including site collections, individual sites, documents, lists, contacts etc.
- Oracle Server:** Backups Oracle Server databases without interrupting Oracle Server services.
- Hyper - V:** Backups Hyper-V environments of any size.
- System State:** Backups critical system state components like the Windows registry, Active Directory, and file and file system information.

On the right, a progress bar shows a 'Full Backup' of 'C:\Drive\Local\MSSQL\Backup\Binary\Testing.mdf' at 2.65 MB, currently at 28% completion (12.07 MB of 43.55 MB) at 509kB/s. Bandwidth usage is at 100%, and the estimated time is 00:01:39.

ABOVE The IDrive client is simple to use and includes backup tools for a range of popular business apps



BELow Servers, workstations, NAS appliances, apps and iPad backups could all be accessed from the IDrive cloud portal

folder using the system name. We easily modified the backup set from the client's Backup pane and could start jobs immediately or run them hourly or daily.

CDP is set from the IDrive preferences, where we could request immediate backups when files were changed and added, or let it run every ten, 30 or 60 minutes. Designed to provide additional levels of protection for smaller files, it works alongside the normal backup schedule and applies to files smaller than 500MB.

The Hybrid Backup feature isn't as clever as MozyPro's 2xProtect; we had to create a separate local backup schedule and point it to a mapped share on our Synology DS1512+ NAS appliance. Even so, it worked fine, managing to encrypt and secure 36GB of test data, comprising 66,600 files, in 5hrs 40mins.

IDrive first runs a full backup and then secures changes in subsequent increments, but for large datasets we recommend you request an Express removable device to be couriered to you. All data copied to it is encrypted, and you then send the device back to IDrive. IDrive Online Backup for Business customers can use this service three times per year as part of the fee.

File restoration was a cinch: we viewed our cloud storage, selected the files and decided to where we wanted them copied. Hybrid restores are run from the Local Backup pane and are suitably fast, with a 690MB video clip restored from our NAS appliance at 56MB/sec.

If all your users log on with the same account, they'll be able to view everyone's backups – unless you create sub-accounts. We set up extra users from our portal and decided what each one was allowed to access.

With the client loaded on our Windows Server 2012 R2 domain controller, we used the Server Backup pane to secure its system state along with our Exchange 2013 and SQL Server 2014 Hyper-V VMs. We ran hybrid and cloud backups of our Exchange database but with the one limitation: although IDrive offers brick-level backup of mailboxes, it doesn't currently support Exchange 2013 to this level.

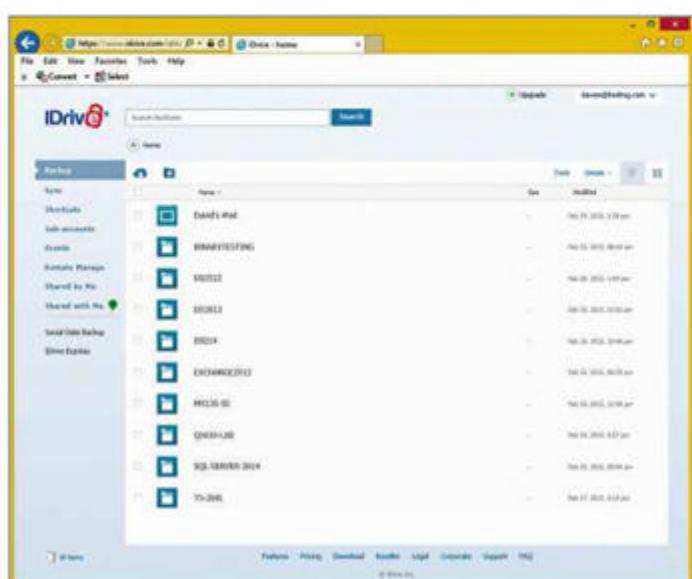
Of course, backup is all very well, but in a time of crisis it's the restore process that matters most. Once again, there's good news: we restored selected SQL databases with ease and, as with file backups, could choose the cloud or local repositories and decide where we wanted our databases copied to. We also found the procedures for dismounting our Exchange 2013 database prior to restoration well documented.

If you want to secure Qnap or Synology NAS appliances, you're in luck – IDrive has an app for that. We tested both using TS-269L and DS1512 appliances and found them simple to use.

In short, IDrive offers businesses superb cloud backup service at a price they won't be able to ignore. After our last cloud backup provider went belly-up, we've been looking for a replacement – and we've just found the perfect solution. **DAVE MITCHELL**

REQUIREMENTS

Windows XP/Server 2000+ • Mac OS X 10.5+



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WD Sentinel DX4200

This Windows-powered storage appliance scores for ease of use but fails to impress as a backup store

SCORE 

PRICE Diskless, £1,304 exc VAT from broadbandbuyer.co.uk

Small businesses hunting for a storage appliance that will slip easily into their Windows network should take note of Western Digital's new Sentinel DX4200. The brain behind this four-bay desktop box comes courtesy of Windows Storage Server 2012 R2 (WSS), so those familiar with Microsoft's standard server OSes will feel right at home.

It's a significant upgrade over the DX4000 (pcpro.link/248wd), which chugs along with Windows Storage Server 2008 Essentials R2 at the helm. The DX4200 has a more usable 4GB of server-grade DDR3 memory and, although its dual-core 1.7GHz Atom C2338 CPU doesn't offer much of a speed boost, it does support up to 16GB of memory.

Another smart feature is that the OS is installed on a 500GB SFF SATA drive neatly tucked away in the side of the chassis. You can fit an identical SFF drive in the carrier on the other side for a fault-tolerant mirror.

The DX4200 runs the Workgroup Edition of WSS and is good for up to 50 users – twice as many as the DX4000. There are some limitations, though: it can only join an existing Active Directory domain; it doesn't support

the Hyper-V role; and it lacks Microsoft's global data deduplication feature.

After attaching a monitor, keyboard and mouse, we ran through a quick-start wizard that sets the language and asks for a password to secure administrative access. After a reboot, you can enable email alerting and apply WD's software updates – and that's it.

There's only one app to play with: Western Digital's StorCentral provides a basic dashboard showing storage status, alerts and system utilisation graphs. When we wanted to configure storage, it stepped aside and handed us over to the Windows Server Manager interface.

Hardware RAID isn't available for the four main drives, which are configured as Microsoft Storage Spaces. These combine selected drives into a single pool that can be expanded on the fly into any spare ones. Within our four-drive pool, we created virtual disks and chose from two- or three-way mirrors or parity resiliency, which is essentially software-managed RAID5. An advantage of Storage Pools is that thin provisioning can be enabled on a virtual disk and will apply to all NAS shares and iSCSI targets within it.

Parity volumes provide the best redundancy, but they'll affect write speeds. Copies of a 50GB test file from a Dell PowerEdge R730 rack server to a share on a parity disk returned a write speed of only 55MB/sec. Read speeds aren't affected: copying the file back to the server saw 113MB/sec. Note that the poor write speeds of parity disks may be an issue if you're planning to use the DX4200 as a



ABOVE The DX4200 is a significant upgrade over the DX4000 and caters for up to 50 users

backup device: securing our 22.4GB test folder and its 10,500 small files averaged only 47MB/sec.

Running the same tests on a mirrored virtual disk delivered better speeds. The 50GB file copy gave us an average write speed of 106MB/sec while the 22.4GB folder mustered a more respectable 77MB/sec.

The DX4200 includes a 25-user licence for the SmartWare Pro backup software but this has one major limitation: it doesn't work. The appliance's mapped shares and iSCSI volumes don't show up as backup targets in the software's interface.

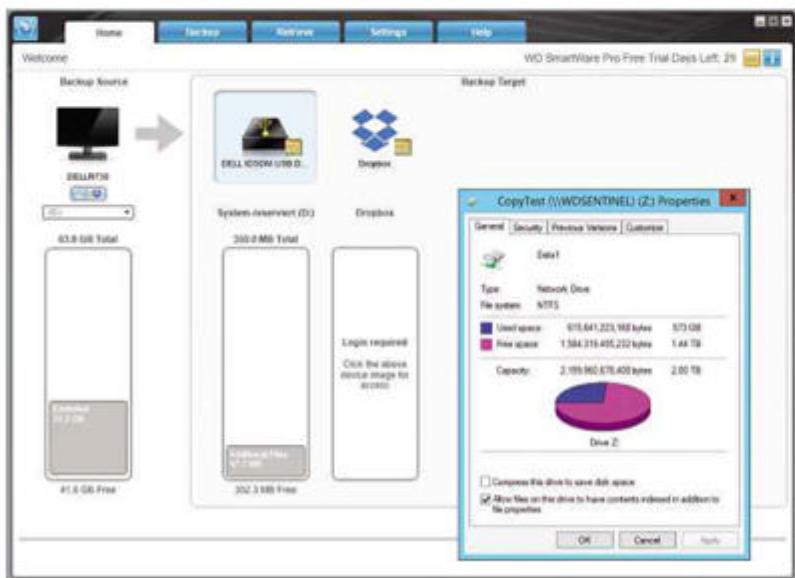
We passed on our findings to Western Digital, which confirmed that we had, indeed, found a bug. It assures us it's working to provide a fix but, for now, you can only use SmartWare Pro to back up data to another local volume, an external USB drive or a Dropbox account.

The DX4200 works well as a simple solution for adding extra storage to an existing Windows network. That said, the low write speeds for parity volumes are a concern and, until Western Digital fixes its SmartWare Pro, you'll need to source your own backup software. **DAVE MITCHELL**

SPECIFICATIONS

- Desktop chassis
- 1.7GHz Intel Atom C2338
- 4GB ECC DDR3 RAM (max 16GB)
- 500GB WD AV-25 SFF SATA boot disk (max 2)
- 4x hot-swap 4TB WD SE SATA hard disks
- Windows Storage Spaces
- 2x Gigabit Ethernet
- 4x USB 3
- external PSU
- SmartWare Pro backup software (25-user licence)
- local/RDP management
- 160x 235 x 209mm (WDH)
- 3yr limited warranty

LEFT Our host system has a share mapped from the DX4200, but the SmartWare Pro software is unable to see it





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THE BUSINESS QUESTION

What happens when the power goes out?

Electrical failures are a fact of life. Darien Graham-Smith finds out how to help your business keep disruption to a minimum

Almost every business today relies on computer systems. That means that even a brief power outage can result in disaster, as servers go abruptly offline and data is lost. The basic advice is to invest in an uninterruptible power supply (UPS) – but ensuring you're protected isn't as simple as plugging in an appliance.

■ What's the danger?

According to UK Power Networks – the agency that maintains power lines in south-eastern England – Britain's electricity network is "99.99% reliable". If you've any experience of hosted services, you'll know that this is actually a poor level of availability, representing nearly an hour's downtime per year, or one minute each week.

Of course, power outages don't run to a predictable schedule. And as Steve Spicer, UK sales manager at Eaton Power, told us, even a momentary glitch can be a huge problem for a small business that isn't prepared.

"It's not just a case of losing power for a minute," he explained. "It could take several hours to get your systems back up, to ensure everything is working, and to recover your data. For a small business, that's a huge impact."

The problem may well become worse before it gets better. The UK has long been facing a "power crunch", and National Grid has warned that our electricity demands this winter could rise to within 2% of our total energy-generating capacity. That means a single power-plant failure could result in a blackout.

Then there are the many types of power disruption that have nothing to do with the

BELow Eaton's Intelligent Power Pod offers a backup solution in the event of a power outage



mains supply. UPS specialist APC's Joseph Seymour has identified seven major types of power problems that can affect your critical systems (see pcpro.link/248apc), ranging from voltage fluctuations to impulsive interference. These can be caused by electrical faults on your premises, or simply by other electrical appliances operating from the same circuit.

The good news is that in all cases the fallback solution is the same: a UPS unit that will ensure your servers aren't abruptly switched off, or indeed blown up, when the unexpected occurs.

■ What a UPS can do

It's easy to think of an UPS as a one-stop appliance that will keep your office working until the power returns. In reality, the little £50 units you'll see in PC World might do the job for a single PC, but you'll need a bulky and expensive rack of batteries to keep your whole business running for any length of time. Professional UPS devices are intended simply to buy your systems enough time to close down cleanly without losing data.

"It's all about short-term protection," explained Spicer. "If it's going to take you two hours to shut everything down and move onto a laptop, we'll supply three hours of runtime to make sure you can do that."

If you need your on-site servers to keep running no matter what then your best option is to invest in a generator, which can kick in when the power goes out and burn diesel or some other fuel to keep it going. If you're using virtual servers, though, there may be a simpler solution: provision some backup capacity in a remote data centre, which can kick in if the primary servers fail. In this scenario, all you need is an UPS that can keep your business ticking over until the switchover is complete.

Modern UPS units can even initiate the process for you. "Our UPS units integrate with virtual environments such as VMware, Microsoft and Citrix," explained Spicer, "so that if your systems switch to battery power, a live migration to your backup site will be automatically triggered."

"That's great for smaller businesses, where staff won't be there at night, or working at weekends. If your IT guy receives a message saying that there's a problem, he doesn't immediately have to rush into work, or log in from home to start a migration."



■ Getting the right provision

When planning your UPS system, it's important to think beyond the initial installation. "Most single-phase UPS batteries are classified as 'maintenance free,'" noted APC's Justin Solis in a white paper (see pcpro.link/248apc2), "which leads many users to incorrectly assume that monitoring and maintaining UPS batteries is unnecessary." In reality, "maintenance free" merely means that the batteries don't need to be regularly topped up with acid – it certainly doesn't guarantee they'll never fail or run down.

"The UPS is a consumable item," confirmed Spicer. "It depletes, especially in high temperatures. If it isn't regularly maintained, or replaced, then one day you'll need to use your UPS in anger, and you'll find you have a problem. That's why we offer service contracts, so we can come along and carry out a regular health check on your UPS, and make sure you really are protected."

UPS units aren't immune to hardware failure either – which is why more sophisticated units offer remote monitoring, so that if a fault should develop, the service provider can respond right away. Your IT manager doesn't need to take any action, or even necessarily realise that anything's amiss. "We can have an engineer on his way with spare parts before the business even knows it has a problem," laughed Spicer.

With that understood, the first question you'll need to ask is how much protection your business actually needs. Many UPS suppliers

offer online tools that you can use to estimate your needs, as well as the maximum load you might need to cope with in extremis. But it isn't as simple as totting up the watts: you also have to consider what degree of redundancy you want – after all, UPS is an emergency technology, so you don't want to take chances.

Then there's the knotty question of how your needs might change in the future. "Data-centre loads aren't static," noted APC's Richard Sawyer. "IT equipment will be under a constant state of change during the lifetime of the data centre. IT refreshes will, at a minimum, have a three-year cycle, where new, more powerful or efficient devices will be installed." Your UPS options may look different depending on whether your business anticipates beefing up its servers, or scaling down its on-site requirements.



"The UPS is a consumable item – it depletes. If it isn't regularly maintained then one day you'll find you have a problem"

BELOW Modular UPS units ensure you can change your backup power plans as your business grows

Thankfully, many manufacturers offer scalable, modular UPS units, so you don't need to spend money on batteries to power servers you don't yet own. A correctly provisioned UPS is cheaper to run, too: "You certainly don't want to be provisioning power for a big data room if you're using only 10% of its capacity," Spicer explained. "UPS units are designed to be most efficient when they're heavily loaded, so make sure you're using as much of that UPS' power as possible."

■ Calling in the experts

Clearly, power protection isn't something you want to try to bodge your way through. As Spicer related with a laugh, "Someone recently said to me: 'I can talk to you all day about scripting and programming – but power is dangerous!'" Even once the system's in place, training can be an issue: "I've seen people plug their fridges and vacuum cleaners into their UPS. And I've seen people accidentally turn off their own UPS units."

Happily, there's no shortage of outside expertise to draw on. UPS manufacturers and resellers will be happy to help you specify and install your UPS; many will even throw in a pre-sales site survey to ensure you have sufficient power provision for future expansion, as well as post-installation training. You'll have gathered by now that UPS isn't the set-and-forget proposition you might have hoped for – but it's very much a case of better safe than sorry. ■



The expert view Steve Cassidy

So, you're a modern business, with a DSL line and a stack of laptops for your team. A short power outage is no problem for the laptops, which contain batteries. Unfortunately, you're probably also reliant on cloud services, and on the hardware devices that link you to them – routers, firewalls, wireless repeaters and so forth. And all of these aren't protected by the typical UPS.

That's because such small-scale hardware tends to come with plug-mounted transformers, while a business-class UPS is likely to want female IEC connectors. You can find SoHo-grade UPS units with regular 13A sockets, but these offer a short runtime – and in a small business with limited space and cabling, it's tempting to use these as extension leads. This means that as soon as your power trips, you'll be burning through your battery to keep the photocopier up and running.

It's best to spend a bit more money on a power bar with angled 13A sockets (so the transformers don't bump into each other) and a female IEC tail to

connect to your UPS. Alternatively, you could ask a qualified electrician to fit a screw-down IEC to a regular extension lead – but check your paperwork first, as insurers tend to take a dim view of modified electrical items.

There's good news too. If you're just now investing in a UPS, you might be surprised at how modest your needs are. Back in the noughties, you could comfortably draw 50 amps in a room with only three server racks. Today, a single desktop PC can do the same work at a fraction of the power draw. The equivalent server deployment wouldn't fill a single half-height rack.

And it isn't only about compute density. Professional kit has become very good at scaling back power consumption when not under serious load, and improved process technologies make a difference too. I've seen Dell run the same Monte Carlo computation on a selection of its servers through the ages, with current meters propped on top: the same job eats up far fewer watts on the newer models, yet finishes much sooner.

Less power consumption also means less cooling is needed. In older data centres, it was common to cool your UPS and everything plugged into it with a separate air-conditioning unit – which, for obvious reasons, wasn't itself plugged into the UPS. With the inefficient hardware of the time this was hardly an ideal situation for anything but the briefest of power blips. For modern, cool-running systems that's much less of a concern.

Software has become less fragile too. In particular, in Windows Server 2012 and later, Microsoft has put work into handling incomplete disk transactions, misbehaving storage systems and so forth. I don't advocate testing your server by yanking out the power lead, but it's an experiment that small businesses all too often carry out by accident. The fact that their files aren't scrambled is a testament to the robustness of the technology.

In other words, disasters ain't what they used to be. You may find you need a lot less power, for a shorter period, than you had assumed – so there really is no excuse for going unprotected.

Connection Vouchers

Steve Cassidy introduces the government funding scheme that helps businesses upgrade their broadband



■ Connection Vouchers – what are they?

Connection Vouchers are a government scheme that can contribute up to £3,000 towards the cost of getting your business a better connection to the internet.

■ Are these vouchers available to everyone?

Connection Vouchers are for businesses only. Your business has to be in the right area too, according to a postcode check, and vouchers must be spent with one of the 650+ accredited partners. That may sound like it gives you a lot of choice, but it could be a sticking point if your current provider isn't on the list.

■ Didn't I hear that the scheme was a flop?

When the scheme was introduced at the end of 2013, take-up was low – but then, at the time, the upgrades on offer weren't so compelling. Over the past year, the broadband industry has become more serious about fibre, and there's now a decent business case for having a dedicated line laid all the way to your premises. It makes sense to grab the deal and have at least part of the cost of the necessary works covered in a single session of form filling.

■ Does my business really need a superfast connection?

Almost certainly, and not just for the obvious reasons. For example, right now, how can you judge whether the cloud-based service you're using is fast or slow? You might imagine that the speed of your connection to the phone exchange is all that matters when it comes to cloud performance, and that communications beyond that point are effectively instantaneous, but this isn't the case. For one thing, cloud-hosting providers balance their own traffic across connections, so you may find that your 100Mbps/sec fibre connection yields only 2Mbps/sec downloads. Plus, of course, a nice new internet link won't download any magic wand for the state of your LAN, whether wired or wireless.

What it will do is support the kind of sideband traffic that can clog up a slower link, which includes smartphone and tablet apps, personal email and the inevitable lunchtime iPlayer sessions. With a fast link, such traffic is a non-issue, from a networking standpoint at

least. And since the £3,000 is all about dropping fibre in the ground, this scheme isn't only about the immediate benefits – the government is thinking about what businesses will need in the next three to five years, and you should too.

■ Can we use the vouchers to upgrade our mobile internet provision?

When it comes to mobile coverage and bandwidth, roving users are at the mercy of the cellular providers, and sadly their service provisions won't be greatly affected by a £3,000 handout. Indeed, demand for mobile internet usage currently outstrips the rate at which mobile networks are growing, and looks set to continue for at least the next five years. If you're concerned about mobile performance, your best approach is to intelligently profile what you're asking your roving workforce to do with their connections. Do they really need a huge pipeline to stream 3D models of central-heating boilers via fossil NT4 RDP servers? Or might it be better to invest in slightly smarter phones and render the models locally?

■ So how exactly do I get these vouchers?

You'll find details at connectionvouchers.co.uk. Take a look at the supplier page: you'll notice that many of the approved suppliers are relatively young firms. Historic infrastructure debt makes it hard for established suppliers to participate in the scheme, so we've ended up with a collection of somewhat new brooms. Opt for a supplier that's knowledgeable about your area and type of business, one that can be relied upon to manage this long-term connection

to your mutual benefit. It's sadly inevitable that some of these small providers will fold in the next few years, leaving their customers owning a fast pipe with nobody at the other end of it.

Although it ought to go without saying, remember too that the voucher deal is only an upfront payment, not ongoing relief from market rates. Take a look at the entire lifecycle cost of your upgrade, not just how cheap it will be to sign up with a £3,000 voucher in your hand.

Don't be too discouraged, however. In bandwidth-starved areas, previously left out in the cold by unimaginative funding and reactive network planning, the Connection Vouchers scheme could make a real difference. ■

“Opt for a supplier that’s knowledgeable about your area and business, one that can manage this connection to mutual benefit”

The jargon

Connection provider An internet firm that specialises in providing bare connections, as opposed to a full range of internet services. Make sure you're clear on what's included in the service you're paying for.

Contention Providers may share a connection between multiple customers to save money. This isn't something a business should live with: use your voucher wisely.

FTTP Fibre to the Premises – a superfast connection that runs all the way to your building. Domestic connections use the cheaper FTTC (Fibre to the Cabinet) architecture that runs partly over slower copper cables.

Voucher Pretend money that can be spent only on upgrading your internet connection – not on other upgrades, however necessary.



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"It isn't only about having the ability to swing the shovel, you need to know where to dig too"

Kroll Ontrack has a level of expertise in hard drive, tape and optical disc technologies that makes it a trustworthy go-to when things go wrong

Yesterday I visited the UK offices of Kroll Ontrack in south-west London, a company that's well known for its data-recovery software tools, but is also famous for its hardware-recovery service. Many years ago, I reported on Kroll's tool for digging inside Exchange Server EDB files, which was staggeringly simple to operate – just run the tool, point it at the EDB file and then walk through the entire structure right down to the mailbox, into the inbox and then down into any subfolders. Then you could search for a particular email or set of emails, and write them out again. This was ideal when a vital email that contained an important contract had gone missing, and you were pretty sure it was in a backup file of a few years ago.

Getting that old backup file mounted into a real copy of Exchange Server would have taken a consultant such as myself some time, but the Kroll tools could retrieve that mail in a minute or two – a significant problem when I came to justify my bill to a CFO for what he perceived

to be a solution implemented in the time taken to boil a kettle for the inevitable cup of tea. The fact that the Kroll software wasn't cheap didn't cut much ice with him...

Of course, it isn't only about having the ability to swing the shovel, you need to know where to dig too – and Kroll's tools had dug me and my clients out of several holes at that time. Since then I've had several clients that have sent off failed but truly irreplaceable hard disks or tapes to the company to recover vital files. The success rate has been very high indeed, but Kroll's invoices have been firmly within the region of "reassuringly expensive". So when the invitation to visit its premises came along, I was sufficiently intrigued to take time out to trundle down there and meet the team.

My first impression? This isn't a fly-by-night operation run by teenagers in their bedroom, nor is it "Bob's Data Recovery Service" listed in the Services column of your local newspaper, claiming to do miracles for a tenner. I was impressed with the



Jon is the MD of an IT consultancy that specialises in testing and deploying hardware
@jonhoneyball

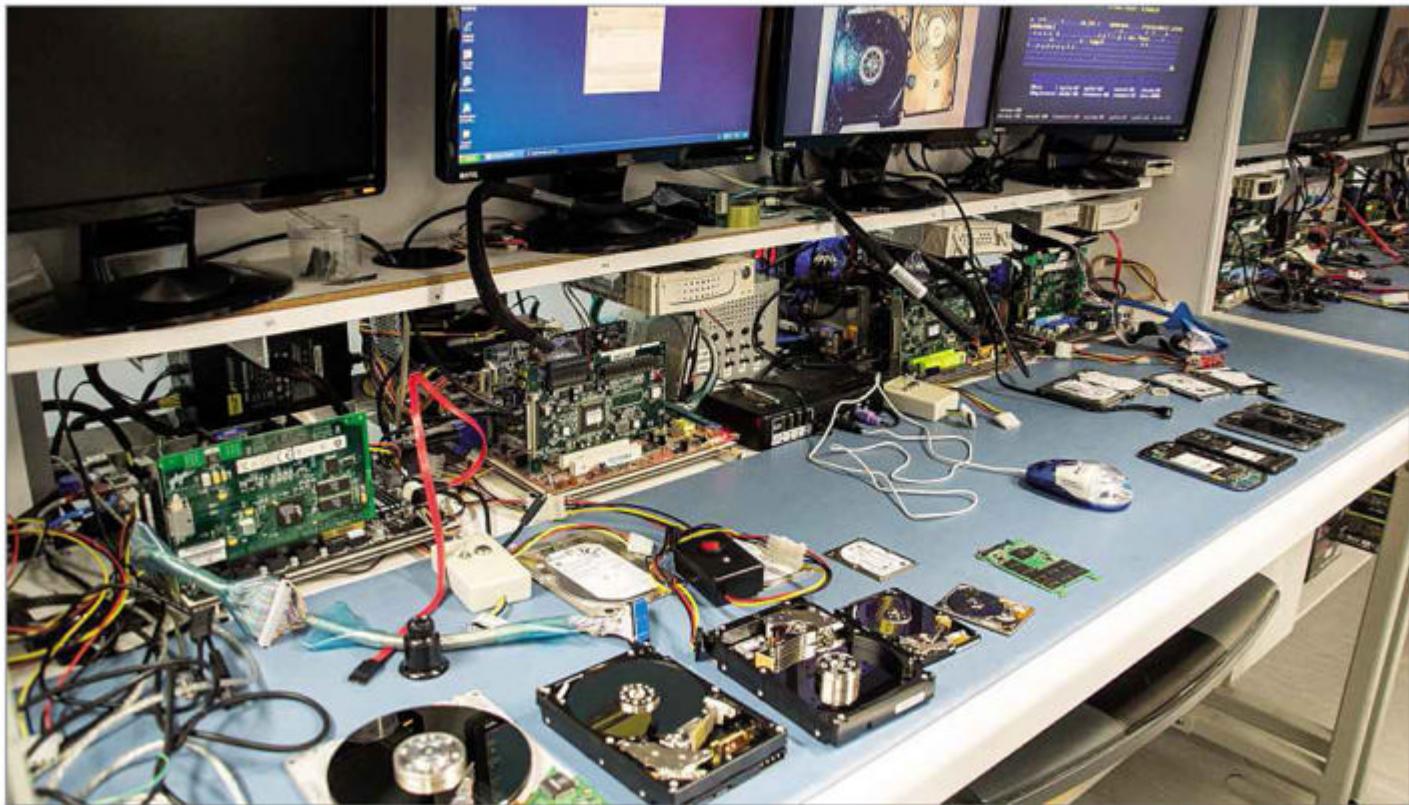
setup. Talking to the engineers and going round the company's clean-room facility, it became obvious that they have a level of expertise in hard drive, tape and optical disc technologies that's comparable to that of the original manufacturers, but that this knowledge extends across almost every brand and every format, from tape through spinning disk to SSDs and solid-state media such as USB sticks and SD cards. Better still, they keep a huge stock of spare parts, often from cannibalised devices, which allows them to replace broken or damaged parts within a drive, for example. Writing new firmware or developing custom hardware jigs for particular recovery tasks are commonplace too.

The methodology adopted by Kroll is straightforward. Let's take a hard disk as an example. First, it's powered up and examined to see whether the physical drive mechanism is in working condition or whether there's damage that requires fixing. To fix a drive, it needs to be taken apart in a clean-room environment to avoid contamination. There are a whole host of issues that could cause physical problems: a crash could wreck a recording head; there could be dirt particles; there could be scoring or other surface damage. The main spindle motor may have failed or the head motors might have glitched. There could be a board-level failure, including broken tracks, fritzed chips or other issues.

Then there might be problems with the disk data, because some drives store their firmware on a reserved area of their own platter – or else they store a mapping file that shows where there's damage to avoid – and if these surface areas can't be properly read then the drive won't start up. To get around such failures, Kroll can rewrite the system areas or reprogram the firmware. Some of this information comes from the manufacturers, but most of the time

BELOW A speck of dust on an opened-up hard disk could result in permanent loss of data



**Jon Honeyball**Opinion on Windows, Apple and everything in between - [p110](#)**Paul Ockenden**Unique insight into mobile and wireless tech - [p113](#)**Iestyn Lloyd**Developments in virtual and augmented reality - [p116](#)**Davey Winder**Keeping small businesses safe since 1997 - [p118](#)**Steve Cassidy**The wider vision on cloud and infrastructure - [p120](#)

it comes from reverse engineering. Replacement firmware, for example, may make a drive more able to get over some physical damage, rather than just failing as it had in its default customer configuration.

Once the drive is physically working, it's time to pull off the data. Kroll uses a proprietary imaging technology that extracts content from the drive: this isn't only the user data, but everything the drive contains, and this disk image is stored away on a server and then passed across to the software team. Working with such an image can be tricky: it isn't too bad when it's a single drive with a single partition, but it becomes far tougher when it's a drive that forms part of a RAID array, because they then need to take account of how the data has been spread across the multiple physical drives by the RAID controller.

Worse still, it could be holding virtual file systems too – for example, those created by VMware or Microsoft's Hyper-V. All of these layers of organisation need to be navigated through *before* you can get at the actual user data. If it's an image from tape, then the data may well be



held in a format that was unique to a particular backup program at some point in history. Once again, though, Kroll has tools that can unscramble this stuff without having to go to the backup program that wrote it (many of us know from bitter experience that a tape image held on a file server may well not even be readable by the originating tape backup software anyway). Deconstructing such an image isn't necessarily easy, but at least they're no longer juggling with a dodgy half-broken hard disk that might keel over at any minute.

At this point it's important that the data's owner has clearly expressed what it is they want to retrieve. Is it a particular mailbox containing a contract that's gone missing? Or the sort of forensic evidence necessary

TOP & ABOVE
Hard disks are disassembled safely in Kroll's dust-controlled clean room

"Kroll uses proprietary imaging technology to extract content from a drive"

to back up a pending court case? Or maybe it's the irreplaceable photos of your grandmother of which there are no other copies. If the intention is to bring back only a defined set of data, then Kroll's engineers will focus on this set and ignore everything else. After all, there's almost certainly no point in spending time recovering the OS files. Once the requested data has been recovered, it's sent to the customer; Kroll holds onto the image for about a month before deleting it, just in case the customer didn't receive the recovered data or decides they need more items to be extracted from the image. Kroll can of course archive an image for indefinite hold if requested, for a fee.

To put the whole process to the test, I was asked if I had a broken hard disk that they could work on, and by coincidence my good friend Peter had just given me a laptop hard disk that had recently died – it powered down one day and his laptop refused to boot. My own initial investigation, using an external SATA-to-USB converter cable, showed that there was no visible file system on the drive, and that rather more worryingly there was a noticeable ticking sound that suggested something was wrong with the head mechanism. I told Peter that I couldn't see anything on the drive and that it was probably dead. I did

think that it might be worth building a new partition table on it in the hope that some data-scrubbing tools could then scan each sector and perhaps reconstruct some usable data. I've done this before with some success, even though it takes a while. The "Deep Scan" mode of Recuva Professional has sometimes scraped together files for me successfully, but as with any sort of recovery process, you're lucky if you get anything.

I created a simple NTFS partition on the drive, which did a quick format only, then ran Recuva over the drive and let it run overnight. In the morning, it had found a bunch of OS system files but nothing that was of any value to Peter. I had to tell him that this time I was certain the drive was dead and that we wouldn't get anything from it.

Kroll's PR team must have been listening, just like International Rescue, because within a day I'd received that invite not only to visit Kroll but also to submit a dead disk for analysis! Peter's disk was an ideal candidate and so I sent it down for preliminary analysis.

While in the clean room, I sat down with the engineer who'd examined my disk and he explained that the drive had two platters, and hence four sides – one side was heavily damaged, but the other three were fine. They tried changing heads and so forth on the damaged side, but this didn't help. He said they'd managed to image off about 76% of the disc, 75% from the three good sides plus a small amount from the damaged side that was otherwise unreadable. As I'm writing this column, these data images are being analysed and files are being extracted: at the last count they'd managed to get around 40GB of useful stuff off the drive, ignoring OS and application files. If they can pull off all the photo files then I know Peter will be delighted.

Which brings me to the question of cost. Kroll will do a preliminary examination for home users for free, allowing them to calculate a fixed price to recover the data. For home users this will typically run from a few hundred pounds and go up according to difficulty; for business users, the cost will be considerably higher. I now understand why this is – the



recovery process becomes far more complicated once you move away from a simple single laptop drive up to RAID arrays, virtualisation and complex application processing, all of which add huge headaches to the job. Very often, recovery for a business may involve extreme time pressures too: when a failure on a Friday night requires a working server to be ready for 8am on Monday morning, for example. Kroll has the capability to work 24/7 and through weekends, but all of this has to be paid for.

Having now seen exactly what's involved, the capital investment and the calibre of technical expertise applied, I'm not surprised at the cost of doing this work. What might have first felt like a painful invoice has been put into perspective. What's also clear is that you'll require Kroll Ontrack's services only if you've truly screwed up – say, if you're embroiled in a legal case and need to pull back data from old tapes. Kroll claims that almost 90% of the Fortune 100 companies have used its services over the past few years. On the one hand, I'm impressed at the company providing service to so many large and successful companies;

ABOVE Kroll keeps a stock of old hardware, including this motley collection of tape drives

"I'm horrified at the thought that so many companies still get into the type of trouble that requires such specialised recovery services"

on the other hand, I'm equally horrified at the thought that so many companies still get into the type of trouble that requires such specialised recovery services. Of course, due to confidentiality, Kroll simply will not reveal who its clients are or what services each requires, and rightly so.

What have I learned? That there's much you can do to sort out a disk failure at home, but be sure you know what you're doing before you start. Kroll has some tools you can download for free, which are a good starting point. Writing anything at all onto a dodgy disk opens up a huge can of worms, and may result in the loss of the data you're trying to save – at some point you need to decide how important this data is, and what you're prepared to do to get it back, even if that means paying a grown-up to do the work for you. It might be tempting to hand over your irreplaceable hard disk to a good mate who promises he can get everything back – at the cost of a few pints at the pub – but I'd strongly urge caution. Despite warning a good friend that you might not be able to get anything back, and that

you might well make things much worse, it's not uncommon for such a friend in need to become a pain in the neck. They simply don't listen when they're in panic mode.

Will I be using Kroll in the future? To be blunt, I hope not. I hope that I have sufficient backups, archives, multi-site solutions and so forth in place that I'll never need to ring its number again. But if I do, I'm now wholly confident that the company is equipped to do the work – and to the best level in the industry. Of course the first thing I did upon returning to my office was to check the archives to tape, to check the on-site and off-site replications, and to ensure that I've dotted every "i" and crossed every ". If I do ever end up having to call Kroll then it will be as a result of something spectacularly bad, and at that point I'll simply be grateful that it's there. I'll report back next month on how much data the company managed to retrieve from Peter's laptop drive, and hopefully be able to provide some idea of what it would have cost. In the meantime, please check your own backups and archives.

Windows 10 for phones

I've been using the new build of Windows 10 for the Nokia Lumia 610 phone. As I've said here before, I'm quite excited about Windows 10 and the good work that Microsoft is doing to pull itself out of the hole in which it dug itself.

But – and this is a big but – with regards to the platform on the phone, there's little here for me to get excited about. Maybe the problem is that it's a lowly Nokia 610 handset, but I'm finding it hard to see any reason to move across to it as my primary platform. Nothing here makes me dribble and drool, and that simply isn't good enough.

Windows Phone has a minuscule market share, and it will need something truly spectacular to change that. I accept that this is only an early build, and much can change before release, but history shows us that this "much can change" aspiration quickly turns into a "little actually changed" lament. I'm still living in hope, as we really do need a strong competitor to iOS and Android.

jon@jhoneyball.com

PAUL OCKENDEN

"We're still chopping down trees and squirting stupidly expensive ink over them, and that isn't going to change"

Paul investigates printing options for mobile workers, looks into cheap thermal imaging, and attends a virtual wine tasting

Can you remember the first time you heard the phrase "the paperless office"? It was spouted on TV programmes such as *Tomorrow's World* and in newspaper and magazine articles in the mid-1980s. Within a few years we'd no longer have print-outs, they said, because everything would be stored digitally and read off a screen. Thirty years on, and there are probably more piles of paper on my desk than ever before.

We've greatly reduced printing certain types of documents, mind you: invoices and receipts are now generally emailed rather than posted, cheques have all but disappeared – and the postman now delivers mostly marketing materials rather than useful addressed mail. And of course many of us consume our media onscreen these days; you might even be reading this column on a PC or a tablet.

Paper still proliferates, however. Go for a walk around your local technology superstore and you'll find there's as much shelf space devoted to printers (along with their paper and proprietary inks) as there is to tablets. We're still chopping down trees and squirting stupidly expensive ink all over them, and it looks like that isn't going to change anytime soon. But what does a mobile worker do when they need to print something?

If it's only for archival purposes, there's a veritable shedload of technologies and protocols available to route your printing via the internet to a remote laser or inkjet sitting back



Paul owns an agency that helps businesses exploit the web, from sales to marketing and everything in between

[@PAulOckenden](https://twitter.com/PAulOckenden)

at home or at the office. The big players in the consumer and SME space are Apple with its AirPrint service, and Google with Cloud Print, but there's a plethora of other players in this market, including Cortado and Mopria. The majority of the printer vendors also have their own proprietary systems and apps. Then there's the Internet Printing Protocol (IPP) standard, which is a bit basic but does at least support access control and encryption. Finally, if you're VP Ned into your corporate infrastructure, you can even use shared Windows printers.

With all of these options available to you, you're bound to find one that suits, but there's a massive "gotcha" to watch out for. The man who looks after my company's burglar-alarm system tells me he's receiving an increasing number of call-outs to investigate apparent system faults where an alarm goes off by itself during the evening. On deeper investigation it often turns out that a printer spewing out paper across the office floor – following a remote worker setting a huge document to print – has triggered the movement sensors! It's a problem that can easily be avoided, either by siting your alarm detectors out of view of the printer or the floor around it, or perhaps by setting time limits on the print queues so that documents can't be printed when the office is unoccupied.

But if you need the ability to print wherever you are – a contract for someone to sign there and then, for example, or perhaps you're a GP who

BELOW Print on the move with Epson's WorkForce WF-100W portable A4 inkjet



needs to leave some information about an illness or medicine while visiting a patient at home – there are several portable printers available on the market. I've looked at several and the best I've been able to find is Epson's WorkForce WF-100W. Folded into its stowage position, it's around the size of a box of tissues, although at 1.6kg, it weighs considerably more. You'd certainly notice it in your briefcase or rucksack, but it isn't going to strain your back.

The WF-100W is rechargeable: it can be topped up via the mains, your car or even the USB port on a laptop. It will print either via USB or Wi-Fi, and the neat thing about its Wi-Fi support is that as well as supporting the usual cloud-print services such as AirPrint, Google's Cloud Print and Epson's own Epson Connect, it can also use Wi-Fi Direct so that laptop, phone or tablet can talk to the printer without a wireless access point – in effect, the printer is its own WAP. The WF-100W isn't the speediest printer – it's comparable to a mid-range inkjet from three or four years ago, at less than 10ppm for simple text – but its colour print quality on plain paper is excellent. It will print photos, too, although this isn't its forte.

It employs pigments rather than dyes for all four ink colours – C, M, Y and K – so the documents you print will dry quickly and won't fade in sunlight or smudge if the paper becomes wet; this is important when printing materials to leave behind with customers or patients. (Some other portable printers use pigment for the black but dye-based inks for the subtractive colours, since the latter offer superior-quality photo printing.)

If you're a Windows user the printer driver is built in, but if you have a Mac you'll need to grab the driver from Epson's website. Once you're set up and connected, it's incredibly quick and easy to use. If you're a mobile worker who needs on-the-spot printing, I really don't think that there's currently a better option out there than the

Epson WorkForce WF-100W – it's a brilliant solution for colour printing on the move.

Don't forget your thermals

You've probably noticed that I'm a bit of a collector of gadgets, and if you are too then you may well have looked at thermal imaging cameras – and thought them a great toy to play with. Depending on your job, you might have even considered one useful: plumbers can see leaks or blockages in pipes and sludged-up radiators; mechanics can spot thin spots on exhaust pipes; electronics tinkerers can see hotspots that show where more ventilation is needed, or detect electrical shorts on a PCB. You may even have done a quick internet search for such devices to find out how much they cost, then wiped a hot tear from your eye and gone off to do something else...

Yes, thermal-imaging cameras have traditionally been eye-wateringly expensive, with the most basic models starting at around a couple of grand, quickly heading upwards for models with a decent specification. This puts them completely out of the reach of many small businesses, and they're certainly not the kind of drunken eBay impulse purchase that any gadget nerd might make. But that all changed last year – well, sort of – with the release of the Flir One.

Flir is probably the best-known thermal-imaging camera maker, and the One is a special low-end camera designed to work with the iPhone 5 and 5s phones (an Android version is set for launch imminently). At only £200, it's far cheaper than traditional thermal-imaging kit, but it isn't without its limitations. The resolution of its thermal sensor is only 80 x 60 pixels, which would obviously yield terrible picture quality, so it partners



ABOVE The Seek Thermal XR simply plugs into the bottom of your phone

this sensor with a normal optical sensor. This merges the two images, using the thermal data only to "colour in" the visible light image, giving the appearance of a far higher resolution. Yes, this is a bit of a hack, but to be fair it works quite well. For me, a bigger limitation is that the current version of the Flir One ties you not only to a single phone, but to last year's model at that, which is too much of a compromise.

Incidentally, one of

the biggest changes as you move up Flir's model range is to the claimed resolution of the thermal-imaging sensor (or bolometer, if we're being technical): for example, the £900 E4 model has a resolution of 80 x 60, while the £3,500 E8 offers 320 x 240. The main guts of both models are pretty much identical, however. This was discovered by Mike Harrison, who you might have come across via his "mikeselectricstuff" YouTube channel. At pcpro.link/248flire4, you'll find Mike's teardown of the aforementioned E4, and after you've watched that head over to pcpro.link/248fliri, where you'll find Mike's instructions for upgrading the configuration to make your cheap E4 work just like an expensive E8. What's not to like about that?

But back to the Flir One and its sneaky double-camera hack: it now has a competitor called the Seek Thermal XR (thermal.com), which is expected to cost roughly the same as the Flir One. There's a cheaper, non-XR version, but the lens on this model can't be focused (manual focus on the XR version allows you to detect objects that are further away or closer to the user). The Seek Thermal differs from the Flir One in a few areas: it's available in both iOS and Android versions; the iOS version isn't tied to a particular model of iPhone; and it has a pretty decent native resolution of 206 x 156 pixels, so it doesn't need that twin-camera fudge that the One employs.

It hasn't yet launched in Europe, so you'll need to import it from the US – mine arrived three days after I'd placed the order. I've been using the Android version, and it works well. It's a neat little unit that plugs into the bottom of your phone. The only possible gotcha is that it expects the micro-USB connector to be the right way up (wider face towards the bottom of the phone, narrower face

"You may have done a quick internet search for a thermal imaging camera to find out how much they cost, then wiped a hot tear from your eye"

nearer the screen). But if your phone has an upside-down connector, or one on the side, all is not lost: you'll just have to use an adapter or cable to rotate it through 180 degrees, which somewhat spoils the neatness but is perfectly acceptable.

When playing with the Seek Thermal XR, I found that it even works as a primitive form of night vision. I was able to find my way around a room that was pitch black (apart from the light from my phone screen, which was kind of cheating!).

One thing you'll find with pretty well all thermal cameras is that, from time to time, the device emits an audible click – the bolometer needs to frequently recalibrate itself by sampling something that's at ambient temperature, and that clicking is a plastic blade being pulled into the field of view of the sensor by an electromagnet to enable this calibration to take place. It's seamless, and you won't see any interruption or flickering of the display.

I reckon the Seek Thermal XR beats the Flir One hands down, and if priced at around £250 (which is what I'd expect when it reaches these shores) it's in the range where a serious gadget nerd might buy one as a toy. But it isn't a toy – since I've had mine I've used it both inside and outside of my house to determine from where the cold is sneaking in and therefore where the insulation needs to be beefed up (or, conversely, my expensive heat is escaping). And I'm sure that, in time, I'll find plenty of other uses for it too.

Radio on

Regular readers of this column will know that I'm a fan of finding alternative uses for existing technology. There's nothing I like better than taking kit I own and finding a novel use for it. It's even more satisfying if you can take a cheap, "toy" technology and make it work in a business environment.

Recently, for example, a company run by a good friend invested a small fortune setting up a special RF measurement lab to allow it to maximise the shielding on the equipment it manufactures, and I was invited along to admire it. I took along two items: an RF explorer, which is the brilliant handheld RF monitoring



tool that I wrote about in issue 221, and a small, cheap AM/FM radio.

The expert in charge of the lab demonstrated his fancy spectrum analysers and data recorders, and how different shapes of shield cut down on the RF noise emitted. He was somewhat taken aback when the handheld £250 tool in my pocket could replicate his results, and even managed to spot some noise that was beyond the range his fancy kit was looking at. Then I took out the cheap radio, which, although lacking a fancy spectrum display, was easily able to detect (when tuned between stations) how effective the various shielding solutions were.

Now I'm not for one moment suggesting that this company was wrong to invest in the new lab and expensive equipment, and I'm certainly not suggesting that its fancy test equipment could be replaced by an AM pocket radio set. I'm simply pointing out that – particularly in quick one-off situations, or perhaps in emergencies – a bit of lateral thinking allows all kinds of technology to be used for purposes for which it wasn't originally designed. Which leads neatly onto...

Video to the vineyard

I was recently part of an online wine-tasting event hosted by Citrix. It was used to showcase the company's GoToMeeting videoconferencing system. Now, anyone who regularly endures videoconferencing will know that it can be a dreadful experience: the majority of virtual meetings that I've attended over the years could have been far more productively conducted via a series of emails, or perhaps a collaboration session using Basecamp. But no, people insist on holding virtual meetings, and some of us get dragged into them.

ABOVE Citrix GoToMeeting is a great tool for hosting a virtual meeting. Or a wine-tasting session!

"The wine tasting was a great way to demo the technology, and about as far removed from a typical virtual meeting as it's possible to get."

Given that so many people find it a painful experience, it must be quite difficult for videoconferencing vendors to showcase their systems to potential customers, or indeed to journalists, so it was a stroke of genius by Citrix to come up with the idea of an online wine-tasting session.

A few days before the event, a guy

turned up with a box containing a selection of wines, a corkscrew and a webcam, and then at the appointed hour a group of us joined a virtual session with sommelier Akos Hervai, who runs the company Clusters To Wine (sommelierservice.co.uk). Akos led us through a session lasting an hour and a half, tasting the wines, and teaching us what we should be looking for when buying wines for ourselves. It was an enjoyable session, and Citrix GoToMeeting worked flawlessly throughout, allowing all of the participants to interact. It was a great way to demo the technology, and about as far removed from a typical virtual meeting as it's possible to get.

Incidentally, there was one extra thing I learned that evening. You may recall that I mentioned there was a webcam in the box alongside the wines. Well, at first I didn't use it, relying instead on the camera and microphone built into my MacBook Pro. Around halfway through the session, however, I switched to using the supplied Logitech C920 webcam – and the difference was immediately apparent. Even on my small preview screen I could see that the Logitech produced a much sharper image (probably because the camera has adjustable focus rather than the fixed focus of the Apple camera) and the other participants noticed how the audio was much clearer too.

Prior to my wine-tasting evening I'd have run a mile from videoconferencing, either with my journalist hat on or in one of my various real-world guises. But Citrix has managed to convert me and I can see that, given the right system, online meetings can be effective. Now if you'll excuse me, I have a couple of bottles that need emptying...

@PaulOckenden

IESTYN LLOYD

"We're learning the vocabulary for an evolving medium, which is ultimately a new, magical type of interaction"

Developing virtual- and augmented-reality content is exciting, but it's an education and is throwing up many challenges

It's three years since I backed Oculus Rift on Kickstarter – following a chance meeting with its creator Palmer Luckey – and much has happened since. Facebook has bought Oculus for \$2 billion, the Samsung Gear VR is on sale, and the internet is abuzz with rumours about Valve, Sony, Microsoft and Google's plans for virtual and augmented reality.

I'd been making 3D games, apps and AR for years, so I found myself in a great position to transition to VR. The majority of my work now is creating VR and AR content for companies that want to produce high-end, immersive experiences. I've worked on training tools, games, architectural visualisations and art installations. Those may sound very different, but there are a number of common factors to almost every experience.

The first complaint with the new wave of VR was: "I can see the pixels!" We started at 1,280 x 800 (640 x 800 per eye) with the Oculus DK1, then went up to 1,920 x 1,080 with the DK2, and now 2,560 x 1,440 with the Gear VR. Pixelated images are less of a problem already, and even when they are noticeable, the brain learns after a short time to ignore them and you're left immersed in the virtual world.

In a recent project, I was able to partially overcome issues with screen resolution via supersampling. This technique renders the image at a higher resolution, then downscales it for the head-mounted display (HMD). Although we were still using the same physical resolution, it benefited from anti-aliasing,



Iestyn is a freelance Unity consultant, specialising in VR, AR and new technology. He won a BAFTA once, but doesn't like to mention it.

@yezzer

"As the resolution on head-mounted displays increases, we require more powerful GPUs"

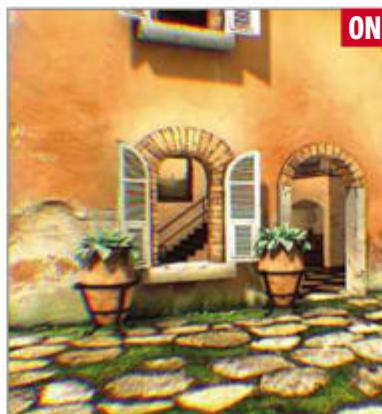
BELOW Thanks to the use of supersampling, images are far less pixelated

reducing visible pixellation and giving a smoother-looking result.

As the resolution on HMDs increases, we require more powerful GPUs to render these images. This leads to its own problems: if you play a demanding VR experience on mobile for too long, the chipset can overheat, and you'll need to take a break while it cools down. We need hardware manufacturers to step up: demand for high-end VR content on both desktop and mobile means that customers will need more powerful GPUs, and higher-resolution screens on their mobile phones and HMDs.

Another limitation of the current generation of devices is the frame rate. Not only do we need to match the refresh rate of the screen on the HMD – 75fps for DK2 – but the 3D environment must be rendered twice, once for each eye. For complex scenes, this is a huge load on the GPU, and many cards more than a year or two old will struggle. It's worth noting that the Nvidia Optimus chipset found in many laptops struggles to keep up 75Hz at the required resolution, and Oculus doesn't recommend using laptops for VR in general.

These issues are magnified when developing for mobile VR. The same constraints apply, but you're given a less powerful GPU than is found in desktops – and in the case of the Gear VR, an even higher-resolution 1,440p screen.



There are techniques that can help with the frame rate. Pre-computing lighting data is a great way to reduce the load on the GPU. Lightmapping (pre-computing the light on static objects rather than dynamically calculating it at runtime) and light probes (sampling the light at given positions in the scene) are also useful tools. Occlusion culling is worth a look too: there's no point rendering an object that's hidden by another.

Thought also needs to go into the types of shaders used: for now, you'll see the more realistic-looking content only on the highest-end graphics cards. Geometry needs to be kept as simple as possible and, in general, you don't want to overload your scene with too much unnecessary detail.

Recently, I've been able to choose the hardware on which the experience runs; I always opt for the most expensive GPU that the budget can accommodate. I've had good luck with the Nvidia GeForce GTX 780 Ti and 980: these powerful cards provide plenty of flexibility for lighting and effects. I've been able to use realistic-looking shaders with plenty of detail and fancy effects in my projects. Time I'd have spent optimising can instead be spent on creating a better overall experience for the user.

All of the above issues – frame-rate limitations, relatively weak GPUs and low resolutions – will be familiar to those involved in developing 3D applications or games, particularly for mobile devices. The good news is that all that knowledge and experience is handy for VR. One important change to your workflow, however, is the need for constant optimisation. You absolutely must test your content on the target hardware as frequently as possible, and optimise as soon as your frame rate drops. There's nothing worse for the user than dropping frames in VR; it undermines the whole experience, and greatly contributes to VR sickness.

Sickly side effects

Once new users have overcome the initial surprise and wonderment of immersion, the first question they ask is "Where are my hands?" This query points at two major design considerations for VR: spatial awareness and input.

Being able to see your body gives a frame of reference in the world. In the real world, parts of our body are almost always visible and help us understand which way we're facing, whether we're upside down or if

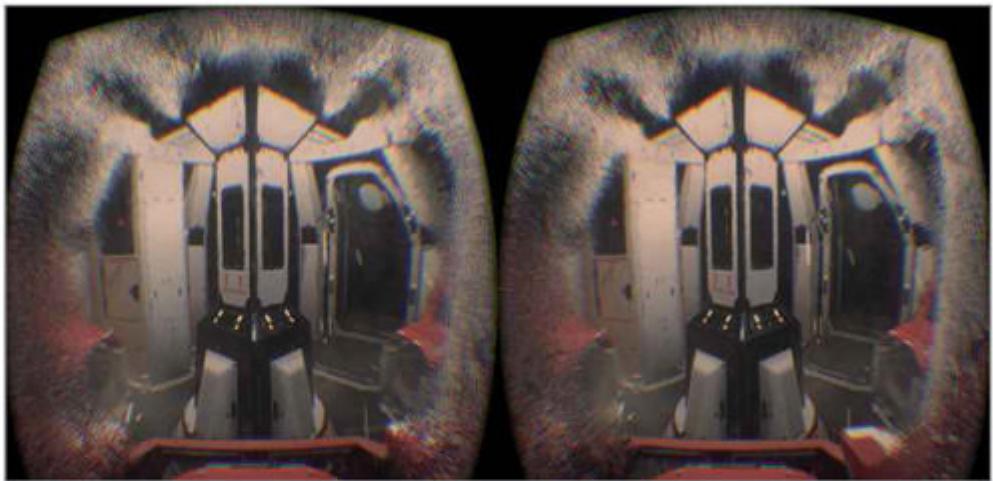
we've turned our head left or right in relation to our body. To have these visual cues taken away can contribute to a feeling of sickness in VR. If the user has freedom to move around the environment, then something to act as a frame of reference for their position and rotation in the world is essential. Currently, a cockpit or similar is a popular workaround.

There are two approaches to solving this in a substantial way: tracking and creating 3D replicas of the body, or using passthrough cameras on the HMD to show actual images of the user's body – in effect, augmented reality. Neither is perfect, and more work needs to be done in the area over the coming years.

An example of a tracking-based solution is to mount a Leap Motion onto the front of the DK2. With some clever software, these dual-infrared cameras detect the position of your hands, allowing us to recreate them in a 3D space. While this is fun to play around with – and the initial feeling of having virtual hands is compelling – the tracking fails when there's too much infrared light in the environment, such as sunlight or halogen lights. It's certainly great to experiment with, but not yet viable for production, unless you can guarantee the environment in which it will be used. This can only be done if you're making a VR experience for a physical installation at a gallery or museum.

The other reason people feel lost without the ability to see their hands in VR is that they're unsure how to interact with the world. While we're accustomed to using a keyboard, mouse or gamepad, none of these translate well into VR. Being unable to see the desk in front of you means spilled coffee as you fumble around, groping to find the right keys, or to pick up the gamepad that was in front of you a moment ago. Being unable to see the buttons you're pressing and struggling to navigate the environment with both your head and your hands can lead to confusion.

While a gamepad is the most common and acceptable solution for now, these devices aren't perfect. We need a new generation of input device that's suitable for this new medium. Luckily, a few firms are working on this – of particular interest are



Sixense's STEM system, which uses wireless motion trackers to detect position and orientation; Perception Neuron, a lightweight motion-capture system; and Valve's SteamVR positional-tracking controllers.

We intended to use Leap Motion on a recent project for input, using a futuristic holographic-style interface – think *Iron Man!* However, we found during our preliminary R&D that the infrared LEDs in the Leap Motion were being reflected back into the cameras from walls and desks, meaning the tracking was failing and our virtual hands were jumping around, contorting into impossible shapes.

Since we were unable to make changes to the installation area, we had to shelve this approach to input and return to the more reliable gamepad. This highlights a need to research all aspects of a VR experience, including the environment in which it will be run.

Despite the current issues with hand recognition, it does look to be the future. Oculus recently bought Nimble VR, a company working on a sort of crossover between Leap Motion and Kinect. Combined with Oculus' purchase of 13th Lab, which specialises in the same kind of advanced optical SLAM (simultaneous localisation and mapping) tracking technology used by NASA, it looks like we'll soon be using our hands to interact within virtual worlds.



ABOVE Lloyd Digital's lighting and effects demo, as shown in the official Unity 5 launch trailer

"While a gamepad is the most acceptable solution for now, we need a new generation of input device that's suitable for this new medium"

LEFT By mounting a Leap Motion onto the front of the Oculus Rift DK2, you can recreate your hands in the virtual space

Menus, text and audio

Another important consideration is how to display menus and text. A diegetic and spatial UI within the world works incredibly well; interface elements presented within the environment are far more natural for the user to interact with. Conversely, flat panels of text in the foreground of the user's vision that follow the position of the head work badly; they're one of the most disconcerting and immersion-breaking things you can do. It's also important to realise that due to the limitations of pixel density, only large bold text is readable and comfortable for the user.

Finally, sound is a crucial element of immersion. At a bare minimum, sound must be present in 3D space – damping with distance, and changing position depending on the orientation of the user's head. The best VR experiences use binaural audio engines, which replicate how the ear receives the sound and allow room modelling to determine how the environment affects the sound before it even reaches the ear.

Among all the challenges we're facing when creating VR content, the most important thing to remember is that we're still learning the vocabulary for an evolving medium – one that borrows elements from gaming, mobile development, storytelling and filmmaking, but which is ultimately a new, magical type of interaction. It's by far the most exciting work I've ever undertaken.

If you're interested in dipping your toes into development, I thoroughly recommend it; it's so much fun! If you have a compatible phone, it's as simple as buying a Google Cardboard and downloading the SDK, which works with the free version of Unity. It's easy to get the basics up and running, and within a couple of hours you could be exploring your own virtual worlds.

iestyn@lloydigital.com

DAVEY WINDER

"I suspect our whole public-key infrastructure paradigm is broken if we no longer know whom to trust"

How can the issue that makes Superfish a vulnerability be a safe, trustworthy function within security vendors' products?

I don't want to go over too much old Lenovo Superfish ground – read pcpro.link/248sf1 if you need to catch up – but much of my time in February was taken up pointing my clients and PC Pro readers towards online removal tools such as the LastPass Superfish Checker (lastpass.com/superfish). Without wishing to downplay the seriousness of the vulnerability that Superfish opened up, the period during which people were at risk was pretty short – although it was installed on 16 million consumer laptops, it was limited to those shipped between September 2014 and February 2015. I came across only one person with an unwanted Superfish installation, and by following the simple instructions set out at LastPass they were soon cleared of it.

I was actually more concerned by the software-development kit that Superfish had been using: SSL hijacker from Komodia. A whole bunch of applications use this kit, and one of these – PrivDog – was distributed with the claim that it protected users from adverts that inject malvertising. Unfortunately, as another researcher discovered (pcpro.link/248pd1), this product also opened up a huge potential security hole. Hanno Böck explained that "while Superfish uses the same certificate and key on all hosts, PrivDog recreates a key/cert on every installation. However, [...] PrivDog will intercept every certificate and replace it with one signed by its root key." He continued: "That [includes] certificates that weren't valid in the first place. It will turn your browser into one that just accepts every HTTPS certificate out there, whether it has been signed by a certificate authority or not."



Davey is an award-winning journalist and consultant specialising in privacy and security issues

 @happygeek

"Why are security vendors performing man-in-the-middle attacks against users?"

BELOW Superfish and PrivDog are just the tip of the certificate-squirting iceberg

PrivDog responded quickly with an advisory (privdog.com/advisory.html) explaining which version was vulnerable and scheduling an automatic update for its 57,568 users. Word got out, and this time I pointed my clients to the checker at filippo.io/Badfish, which revealed whether any other SSL-disabling software was running.

That, you might like to think, was that. Oh how wrong you are. Open can, meet worms: the newly raised question is, why are supposed security vendors performing man-in-the-middle attacks against their users?

Let's strip things down to their basics by acknowledging that both the Superfish and PrivDog vulnerabilities were opened up due to "certificate squirting". Superfish did it to permit the injection of ads onto pages you visited, while PrivDog did it to control the source of those ads; security vendors do it so that their products can analyse content for malicious activity from within browsers that employ an SSL/TLS connection.

I've been trying to get my head around this idea: what is it that makes Superfish a vulnerability while security vendors are using the same trick as a safe and trustworthy function? Take a look at Avast's support FAQ, for example, which clearly states that, when it comes to

Superfish, Komodia, PrivDog vulnerability test (updated again!)

Check the box below: If you see a "YES", you have a problem.
Do the test with all browsers installed.

Good, Superfish is probably not intercepting your connections.

Also no other SSL-disabling product was detected on your system.

What's this about? Turns out Lenovo preloaded their laptops with adware that will intercept all your secure connections, and allow criminals to do it, too.

After investigating the Lenovo incident we found out that many other softwares - like some Parental Controls or security packages - do things even worse for your security. This test attempts to detect them all.

HTTPS scanning. "We are using our own generated certificates that are added into the root certificate store in Windows and also into major browsers. This feature will protect you against viruses coming through HTTPS traffic as well as adding compatibility for SPDY+HTTPS/HTTP 2 traffic. You can tune/disable this feature in the settings section."

Great, apart from the minor detail that next to nobody will actually venture that deep into their settings to disable something they know nothing about – and which they've been assured adds an extra layer of security to their system. More to the point, if these good guys can squirt their own CA into your trust store and generate on-the-fly certificates, can't the bad guys, too? The answer is that they can and do – it's called a man-in-the-middle attack, and the difference is one of malicious intent. This raises a further question: where's the balance between them scanning for malware by reading all my "secure" SSL traffic and having them misappropriate said traffic (or inadvertently enable someone else to do so)? Opinion within the IT security industry itself is divided on this one.

Kevin Bocek, vice president of security strategy and threat intelligence at Venafi, told me that when it comes to playing with the trust established by digital certificates "it's not cool, it's not okay and it shouldn't be used on consumers, even by security software. There is the expectation when using a browser with SSL/TLS and green bar that communications are private and authenticated." He said digital certificates are now a cybercriminal currency, selling for £600 each on the dark web. "Outside of security systems run by enterprise IT, security software – especially those used by consumers – shouldn't be messing with digital certificates," said Bocek. He makes a good point: businesses that operate SSL decryption on outbound traffic can have tighter controls and use capabilities such as CA certificate whitelisting to limit the risk of malicious use of forged certificates for decryption, but consumers have no such controls.

Ken Munro, a senior partner at Pen Test Partners, is less convinced. He suggests that the crux of the matter is permissions: "If the end user installed a security product that did man-in-the-middle on SSL sessions, then he/she would be doing so for a reason. That user has made a conscious decision to allow this



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product access to data to perform a function," Munro argued, adding that "the Superfish situation was the opposite".

"Superfish was circumventing security controls that you, as a user, were deciding to take advantage of, and doing so in a manner that left you exposed to all sorts of malicious actors who wish to do you harm," he added. "It's the difference between someone asking for a physical security audit from us and us turning up in the middle of the night, kicking your door in and trying to sell you a Big Mac." Munro concludes that while it's never okay to squirt a CA into the trust store, in some cases there might be a good reason why it's done, and there may be a security benefit to it.

On a simple level, you could say it's all part of the risk equation, and that the small risk of opening up a vulnerability is outweighed by the additional security that such a process brings. But how can we measure how small that risk is? There's no malicious intent, and if we didn't implicitly trust the security vendor, then the big question is why we're using its products at all. But nobody's perfect, and software continues to be a prime area where small imperfections can have huge consequences. If these imperfections exist at a low level and with high privilege – and deliberately introducing a vulnerability into encrypted communications certainly qualifies – the consequences will be even more serious. Security software is supposed to reduce the attack surface, not increase it, and therein lies the dilemma of squirting fake certificates and performing man-in-the-middle attacks, no matter how noble the intent.

Hit Windows+R and then type "certmgr.msc"; now, navigate to your trusted root-certificate authorities store and double-click on certificates. You'll probably be faced with a list of trusted CAs that mean nothing to you. Deleting any would be a bit like playing Russian roulette: at best, sites that had been authenticated by a revoked certificate would now show up as not trusted, so you could decide their fate all over again; at worst, some software updates will simply fail. I don't know who to trust in my

own list of CAs, since many were already installed when I fired up a browser for the first time; that browser's vendor made the trust decision. The Lenovo/Superfish affair shows that this isn't always a good thing, especially when bean counters and marketing men are put in charge of ticking the trust box. I suspect that our whole public-key infrastructure paradigm – with a CA as the single point of trust – is broken if we no longer know whom to trust. It needs to be fixed.

One key to unlock them all: perfect forward secrecy

Superfish users weren't aware that software capable of intercepting their communications had been installed on their machines, since it was done so without their knowledge or consent. Worse still, all implementations used the same private key, putting the confidentiality of user information at risk, not only to those who managed the Superfish service, but to anyone else with the private key. Lenovo claims it was only consumer laptops that had Superfish preinstalled, although business users at the smaller end of the SME spectrum would obviously be among those buying these same machines. The use of a CA certificate placed in the trusted store is something that many organisations knowingly employ as part of their web security or data-loss-prevention solutions to enable them to inspect HTTPS traffic in both directions.

The main difference between consumer and corporate usage – as



LEFT PrivDog got a bad case of the cert squirts

Andrew Wild, the chief information security officer at Lancope, told me – is that "these implementations are most often done with full awareness of the company's management, including HR, legal and privacy teams", and "each implementation typically uses a unique CA certificate with a unique private key". Such cases are clearly different kettles of fish, although Wild suggested that there's a common thread that needs to be understood – the management and monitoring of certificates inside the trusted root store. Wild believes the Superfish incident is a wake-up call for more organisations to start following Google's lead by using "forward secrecy".

Since the end of 2011, Google has used forward secrecy with Transport Layer Security (TLS) by default for Gmail, Google Drive and Google+ users, while Twitter followed suit at the back end of 2013. That's slow progress, but perfect forward secrecy (PFS), as it has become better known, is starting to catch on for good reason: the disclosure of a private key doesn't make the session key available, and so doesn't threaten the confidentiality of all communications secured by that certificate. Wild insisted that "we need to aggressively push websites to support cipher suites that use forward secrecy", and I think he's bang on the money. So what exactly is PFS?

To understand that, you first need to understand, at the simplest level, the way symmetric encryption over HTTPS works, so here comes the dumbed-down science bit. Your computer requests an encrypted communication with a server, which responds by producing a digital certificate and a public key. The two of them then agree on an encryption scheme to use, and further agree to use a "shared" password, which becomes the encryption key for all sessions. Every communication you then have with that server is encrypted using the same key from that initial bit of secure configuration, which isn't problematic, since every other computer that talks to that server will have a different key.

LEFT Examining the Gmail key exchange mechanism reveals PFS enabled by use of ECDHE_ECDSA

BELLOW The Netcraft extension does the same thing, albeit in an easier-to-understand way



What is problematic, however, is the fact that the shared key being sent by your computer (and every other computer) to the server is encrypted, using the public key of that server, to be decrypted by the

Continued from previous page

server's private key. The weak point should now be obvious: anyone who has that private key can decrypt any session by any computer and the now-compromised server. Everyone and their aunt knows the inherent dangers of using the same password for every site and service, and such password reuse is a major cause of data breaches. Essentially, though, this same reuse vulnerability is right there in terms of encryption keys for online services both large and small: that one key can unlock everything. For want of a better phrase, it's a vulnerability that enables the retrospective decryption of data.

The concept of PFS was first described in 1992 by public-key cryptography pioneer Whitfield Diffie in a paper entitled "Authentication and Authenticated Key Exchanges". Like most of the best ideas, it's a simple one, albeit one wrapped up in the complexity of the cryptographers' craft: use-per-session keys that are discarded after the transaction is complete, or after a reasonable period, to allow for the resumption of disrupted sessions. To retrospectively decrypt a PFS communication, every session would have to be attacked independently, and grabbing the session key wouldn't be easy. Even if the attacker were successful, they could break only that one connection.

The PFS handshake is similar to the non-PFS one, in that server and client have to agree on which cipher suite to use for the connection, but Diffie-Hellman key-exchange variants are then used to negotiate per-session shared keys without transmitting the key itself. Such cipher suites will support ephemeral Diffie-Hellman key exchange (EDH) and ephemeral elliptic curve Diffie-Hellman (ECDHE), the latter of which has proved to be faster in operation and is used by Google. Talking of which, the most cited reason for not employing PFS appears to be performance hits on the server, but I'm not convinced about this. I'm told it would most disrupt the bigger end of the business, but Google is pretty big, and it has managed to cope with any performance overhead from using ECDHE without it seemingly affecting users.

davey@happygeek.com

STEVE CASSIDY

"It helps to have experience of poker when sitting in networking meetings so that you can keep a straight face"

Steve gets to grips with hyperconvergence, and does his best to explain the virtues of virtualisation to a business that ought to employ it

Hyperconvergence. "Oh boy, another long word that really doesn't mean anything: please, Steve, don't drag us off into the semantic underbrush this month!"

Come on, steel yourself, because there's a serious point to my story. If you're currently either buying kit for your own network, or working out which cloud provider you ought to be using based on their sales hype, then you're likely to bark your shins against this baffling term and wonder what it means, what you can conclude from salespeople's use of it and how on earth we managed to end up here.

I got to thinking about all this mainly because Dell has launched an appliance – a server to you and me – that makes heavy use of a hyperconverged platform for software-defined storage. You might need to make some coffee, because I'm going to attempt to help you through some of the tedious, eyelid-drooping, winter-grade quilts of jargon that the industry has taken to using when it talks about this kit.

The new box (*pictured below*) is called the XC630, and my colleagues in the art department will doubtless be irritated by its exceptionally thin proportions, at least when viewed from the front. Long-term readers may be staring at it with their glasses on the top of their heads, saying: "Okay, it's a server. So what?" Well, the secret isn't revealed by this picture, I'm afraid, because this isn't any old server – this is a hyperconverged server.

The concept of hyperconvergence is actually mercifully jargon-light considering the design decisions, software, storage and networking that it pulls together. The basic problem is that you can't just keep stacking up disks behind a single CPU and a single network card, which I know will come as a disappointment to many of us. At least one generation of nerds cut their teeth with precisely this server architecture, and have fought off every attempt to break the



Steve is a consultant who specialises in networks, cloud, HR and upsetting the corporate apple cart
@stardotpro

basic equation, right up to retirement. It was, after all, these guys and their purchasing decisions that opened up the market for VMware, demonstrating that virtualisation could save huge amounts of money. I well remember the final result of such an outlook – walking around aisle after aisle of a British bank's server room, gawping at the immense steel sheds full of servers each containing a single CPU (but four sockets), one expansion card (but nine slots) and 4GB of RAM (despite supporting 32).

The fix to combat this incredible misselling and misuse of IT resources, and to try to stem the gently rising tide of data, was to separate storage from the compute resource. This brought us to NAS boxes, which to my mind are a gross distortion by the bottom end of the market of a clever and extremely capable architecture developed in the middle and top spending brackets: no big CPU idling away at 5% of its capacity just to sling bits on and off a disk; no expensive software licences that sit there employing only 0.00001% of their code to do such a basic job. Anyway, I'm going to have to fast-forward here – otherwise, this could easily turn into an overly long discussion of "the road to 2015", quite a lot of which we all know and understand as part of the modern buying and configuration process.

The key realisation was that the volume of data has been sneaking up on us, all the way through the past couple of decades, and that most of the advanced thinking done on our behalf by product designers has been about increasing efficiency, not about raw increases in total system speed. We may have gone from 4MHz to

BELOW The Dell XC630 – it may not look noteworthy, but it is



40MHz in processors in half a decade, but it looks as though the laws of physics have put a stop to that rate of advancement. This is a pity, since all the data that was around back then is still with us. I have some of my early PC Pro columns stored in a folder called BIG200, because back then a 200GB disk was a high-cost extra and I was quite proud of it.

That data volume, and everything that follows from it, is estimated to be only the start of our trouble, because sources of data are set to explode over the next five years or so. ARM will tell you that it has so far shipped 20 billion CPUs, but when you add what's coming next – in the shape of the firm's mbed platform for tiny network-aware device controllers and sensors – that number will soon have grown to 50 billion. Data and its storage is the topic that now gives many people in the IT business a thrilling sense of fear – and the impetus to try to fix what may well become an intractable problem.

The evidence of such intractability is all around us. Indeed, you can't just stack up progressively higher piles of disks every time you run out of room, nor can you expect to keep on keeping on that way. This can be demonstrated using the most common, lightweight bits of IT equipment you can find. My man time over Christmas was taken up by two stupid (but quite relaxing) projects that starkly illuminate this inescapable truth.

One was a cheap deal bought on [ebuyer.com](#): a Lenovo/Iomega/EMC NAS box called the ix4-300D. When it's fed four 2TB drives, it sets up quickly and easily, and the end result shifts large files around at impressive speed. However, it's just as well that I started formatting the single 5TB volume it presented to Windows on Christmas Eve, because it didn't finish formatting until we'd polished off the reserved pheasant on Boxing Day.

The second project was an orphan, cruelly dumped during the festive season into a pile of rubbish and therefore smelling a bit of bacon and stuffing when I found it. It was a Packard Bell consumer PC that turned out to be suffering from heat-induced hard disk failure.

No matter how hard I tried after I replaced the dead drive, I couldn't get this Packard Bell to make use of all six of its SATA drive connections on the motherboard. Even when offered four nice, enterprise-grade 750GB SATA disks, everything would crawl to a halt by squeezing all the I/O through the deliberately brain-damaged chipset that drove this bottom-end piece of kit.

These two examples – a three-day formatting exercise and a piece of gear that presents inviting but useless empty slots and drive links – offer a lesson that applies all the way up the spending ladder: data and storage are overwhelming us, and at a time when all the pundits agree that the major data tsunami has yet to arrive.

NAS must get smarter

This lesson has its strongest impact on the doctrine of the NAS storage box: no longer can you leave these boxes with fossil-era CPUs and less memory than your smartphone. You need them to get smarter so that they can retrieve important parts of your VM's third (or fourth, or 19th) drive quicker than they do the dull and boring bits, or so that they can differentiate between a thumbnail and the full 4K video file it represents.

This is what hyperconvergence is meant to do. Most of the superfast speeds you're used to seeing are actually partial illusions, reliant on the slowness of human reactions and the likelihood that what we want is close to hand. The coming data inundation is washing away all such cheats, and the only thing to do is push back, to add more brains and shove them further out into the disk arrays so that more communication can happen closer to the disks. This will keep up the apparent speed while juggling vast amounts of data. It is, in fact, the return of the proper server.

Local storage, either as SSDs or spinning disks, is now fast enough



ABOVE Nutanix is offering a free guide to software-defined storage via its website

and large enough that a decent CPU and a very sizeable stack of software is required just to populate and manage the terabytes you can pack into a form factor as small as Dell's new XC630. In one of those strange warpings of mathematics that takes simple numbers and mangles them into a brain-twisting end result, the mass of storage that imposes the most CPU stress is at the same time very numerous (there are millions of them) and quite small (they don't take up many bytes, but have to be kept separate).

"Data is overwhelming us at a time when the major data tsunami has yet to arrive"

The mysterious "they" I'm referring to are websites, and the VMs that present them to their readers and developers. I've written here before about containers and the way that large populations of identical VMs can be made easier to manage through their application, but such ease is bought at the price of some seriously difficult work in the machinery – hypervisor-like layers of software-defined storage.

In the case of the Dell XC630, this comes courtesy of Nutanix, which you can learn more about at [nutanix.com](#). I mention this not because I expect you all to become software-defined networking gurus merely from the reflected glory, but because this firm is offering everyone a free copy of *Software-Defined Storage for Dummies*. This isn't the now-traditional 750-page tome,



equivalent to a PhD course in computer science, but rather a slim, hip and bouncy booklet that at least gets you started with the hardcore jargon of this business.

The approach taken by Nutanix and Dell – and by other players in this field – is to try not to rock the boat by requiring you to take on board new operating systems, or long-awaited major releases of your chosen network operating system, before allowing you to release some petabytes for use. Instead, they take your older OS with its storage limitations (and all these OSes have limits: how many logical disks per server; how many sites per web host; how many virtualised LAN cards per session) and encapsulate it within a further layer of software that can freely use a less limited architecture to give you the cheats you need, in the order you decide you need them. And I do mean cheats, because cheating is still a vital part of the picture.

If the basic storage systems had the raw, sustained speed necessary, there'd be no need to push all these brains down through the system hierarchy until they were right up close to the storage bus. However, nobody will buy a product barefacedly advertised as “the best cheater on the block”, so instead the storage business prefers to talk about “tiering” and “deduplication”, which are methods of arranging your data so that there's only one copy plus some pointers to it, or else that the deepest copy never leaves the slow disk and the fastest copy never leaves the flash drive.

Hyperconvergence is in its infancy as a technology, although I suppose if you want to push the point, then the appearance of photo-editing tools on ever-faster, ever-larger smartphones is another example of a hyperconverged architecture. Certainly, I'd go with the idea that the latest, Ultra HD CCTV cameras that push images back to the recording server only when they've detected motion in the field of view count as hyperconverged designs.

If I had to pick a key concept to take away from the emergence of this new jargon term, it's that nobody – least of all Dell – is underestimating the potential impact of the data problem on our everyday lives.



Straight faces only

“Yes, we looked into that virtualisation thing quite a lot and gave up on it. We just don't have a fast enough internet link, you see.” Sometimes it helps to have a little experience of poker (or perhaps of being suspected of tax evasion) when sitting in meetings in the IT networking business so that you know how to keep a straight face.

In the particular situation where that last quote came up, I was already pretty close to outright chuckling anyway, having toured their premises and seen quite a well-delivered and artsy network-device diagram populated with some terribly poor bits of equipment. These potential clients had been very proud of their data-management skills, because they'd kept all their photos and artwork on a separate NAS box connected to a LAN.

Unfortunately, since they'd also spent a lot of their network budget on some pricey Cisco switches to support their swish VoIP phone system, this NAS and their workstations were all connected to the core group of servers over 100Mbit/sec switch ports, which meant there weren't enough hours in the day to stream a complete backup of said photos onto the large, wobbly stack of USB portable drives to which they had, sure enough, been backing up. All well and good, except that nobody could remember making any restores from those backups. (We Real World Computing crew don't share our articles with each other before publication, but no need – I can imagine Mr Honeyball's screams of agony and derision.)

There's no getting away from the inherent problem that an awful lot of people think they're covered against every possible failure just by having something that has “backup” written on it. This client's

ABOVE A poorly designed network can kill your bandwidth – and your backup plans

voodoo-like obeisance to the label on a piece of technology illustrates a worrying trend: not only did its NAS disks fail in a way that neatly sidestepped any fault tolerance inside the unit itself, but its backup regime had never included those network shares anyway.

Its local support company had made only the feeblest of attempts to get them to use the cloud for backup (or, indeed, for anything else) because it had an all-or-nothing mindset. Poor internet links typical of the postcode made it nigh-on impossible for the support company to scoop up all the servers and virtualise them into a 100% off-premises architecture, but it hadn't even tried to cherry-pick the less connection-dependent parts of the data. Even ten minutes per week of decent uplink speed might have allowed for the accounts-package dump files to be stored somewhere in the cloud, and a slightly wider window could have permitted a sensible cloud-based picture library with sync abilities, and thus kept at least a partial archive of that now defunct photo library available.

But no: because it couldn't do the entire deal and have everyone online all the time, the support company in question gave up.

In fact, it had given up twice over, arguably three times: it had offered no honest explanation of the reason for the shortcoming; it didn't stop to appraise whether there were other easy off-site backup wins to be had; and, finally, it didn't make their on-premise systems fit for purpose – and hence a little bit harder to kill – to compensate for this absence of good bandwidth.

So that's the mindset from which the giggle-inducing explanation I quoted at the start was coming.

In the course of giving up on their responsibilities, those local support chaps had decided to spread a healthy dose of fear, uncertainty and doubt about an entire technology, just because BT wouldn't upgrade the local exchange. I found myself facing the unwelcome challenge of trying not to snigger in an unseemly fashion, while at the same time gently educating this management team in the correct meaning and impact of the simple notion of virtualisation.

This was in the same week my brain was melting while trying to grapple with hyperconvergence, providing a neat reminder of the gap between the leading and the trailing edges of our business.

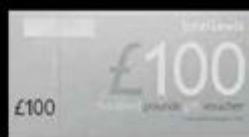
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Futures



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Material world: what's next for 3D printing

Will the ability to make objects from wood, metal and ceramics finally bring 3D printing to the masses? asks **Nicole Kobia**

There's a collection of plastic skulls in the PC Pro office – they've become our go-to shape for testing 3D printers, and that highlights one of the main issues with the machines: unless you plan to stage a unique twist on Hamlet, there aren't many genuinely useful things you can print with cheap plastic.

That could be set to change. At CES in January 2015, 3D printer giant MakerBot revealed it was working on new composite filaments – the materials its printers splurt out to build users' designs. In addition to brightly coloured plastics, by the end of this year MakerBot's line-up of materials will include simulated limestone, maple wood, bronze and iron. Not only do these look better, they mimic the properties of those materials too; the metals, for example,

can be polished to a shine for making jewellery, while the wood composites can be sanded down.

MakerBot isn't the only company to offer new materials. Dutch firm colorFabb has wood and bronze composites similar to those MakerBot is working on, and Shapeways offers printing materials such as steel and wax. Plus, there are Kickstarter projects such as Polymakr (pcpro.link/248polymakr), which is working on soft and flexible materials. Other initiatives include the MarkForged printer, which can use carbon fibre, fibreglass and even Kevlar.

Alex Chausovsky, an analyst at IHS Technology, weighed up whether new materials will be a game-changer for 3D printers. "I saw a

ABOVE Voxel8 is working on the ability to combine materials in one print job

very cool presentation at the Innovations in 3D Printing conference in California, where an architect was talking about using some really interesting materials that I hadn't heard of – such as salt, sand, various ceramics – to open up the portfolio for in-home decorative blinds and room dividers, all the way to full houses and structures," he said.

"Is it a huge deal that MakerBot is introducing these new composite materials? Probably not," he told

us. "But it's supporting this idea that the more materials that 3D printing can utilise, the more potential applications will open up, and that's really the key with additive manufacturing."

"This ability to print with multiple materials – plastics, wiring, metals, ceramics – in one go is what I'd like to see"

BELOW By the end of the year, MakerBot is hoping to be able to print materials as varied as limestone, maple wood, bronze and iron



■ Material change

The materials do add an extra layer of complication, however. MakerBot has had to develop a new "smart" extruder – the piece of hardware that sprays the composite to build your design – that will need swapping out for each material used.

These complications won't help make 3D printers more popular, and Chausovsky thinks they're already too fiddly for mainstream users. "There are certainly those who are makers at heart, people who are going to use this technology to come up with creative MacGyver-like solutions for their home – to fix their broken knobs or handles for example," he said. "For the rest of us, 3D printing is still relatively complicated."

3D printers will become easier to use, Chausovsky predicted, but in the near future he expects the focus will be on making them print faster – they remain slow compared to traditional methods of manufacturing – and on extending their capabilities with materials.

The handful of new composite materials from MakerBot and other manufacturers are only the start, Chausovsky said: the few hundred different materials that can be used with additive manufacturing are a limited selection compared to the hundreds of thousands that can be used in traditional manufacturing.

"We need to continue to increase the availability of materials, while at the same time driving down the cost of those materials; right now, many printers are using this 'razor-and-blade' model, where they're charging a 10x multiplier on what it costs them to actually produce the material," he said. "We need to move towards a model that's more open-source, using lower-cost materials."

■ Combo deals

More, and cheaper, materials isn't the only change Chausovsky would like to see. Since most current printers can build with only a single material at one time, Chausovsky predicted that combining materials will be the next big leap forward. "The ability to print in multiple material categories – plastics, wiring, metals, ceramics, composites – in one go is what I'd like to see," he said.

"We need to continue to increase the availability of materials, while at the same time driving down the cost of those materials"

While we're unlikely to see this happen industry-wide in the next couple of years, there are companies out there that have made a start.

"There's a neat machine I saw called the Voxel8, which is able to print plastic and silver conductive ink in one print job," he said. "This company did a drone print where it printed the wiring for the drone and the plastics all at once."

And once that's possible, the sky's the limit – literally. Chausovsky points to Star Trek's replicator as

the future of 3D printing: push one button to get what you need, with plastics, metals and integrated electronics all in one.

"It will be at the point when I say I want a cup of coffee or I want an apple, and the printer is able to deliver, that these devices will permeate into every house," he said. "Until that happens, I think it's a technology that will be limited to those tinkerer, creative types – and the rest of us are either going to farm out the work to a 3D printing bureau or just continue to buy goods and services in the regular way." ●

Printing electronics

Forget plastic models, faux-wood chess pieces or almost-ceramic vases – if you want to print your own electronics, these companies' 3D printers will let you do just that.

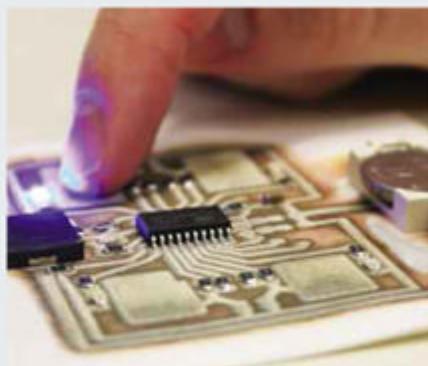
Voxel8

Voxel8 makes 3D printers that can create objects from plastic and silver ink. For example, the developers like to show off a 3D-printed drone, with only the motor added after the shell is built. The idea is a result of years of research by Jennifer Lewis and colleagues at Harvard. The Voxel8 printers will start shipping at the end of 2015 and cost \$8,499 (around £5,746).



Argentum

This machine won't print a fully working electronics device, but it will print the circuitry. Funded on Kickstarter, the Argentum lets you print silver particles onto paper, plastic, glass or other surfaces to build a circuit board. The developer, Cartesian Co, says the system will make it easier to test ideas, but will also let you make wearable electronics by printing onto fabric.



Functionalize

This is another Kickstarter project, albeit one that didn't hit its funding target. The company has instead found a partner manufacturer and is now taking orders via functionalize.com/shop. Rather than a new printer, these folks are making a filament – the material you print with – that's conductive and works with many existing consumer 3D printers.





The upsides and downsides of Tech City

As far as the government is concerned, London's Tech City is a success. But what effect has it had on employment in the area – and what are the downsides? The LSE's Dr Max Nathan is trying to find out what has worked and what hasn't

TECH CITY AS a concept was invented by the government, but start-ups were clustering in the area once dubbed Silicon Roundabout long before David Cameron's 2010 speech pledged support for tech firms in East London.

Since then, the Tech City project has spread further afield – the most recent report from the quango behind it was dubbed Tech Nation – but it's difficult to determine what effect the government's support has had. Dr Max Nathan, a researcher at the London School of Economics, is working to find out, and gave a sneak peek into his preliminary findings.

■ You're looking at job growth in Tech City. What are your findings so far?
We have data from 2007/8 to 2013, and it's basically on an upward trend. The preliminary findings show that the number of jobs in the area were actually going down before 2010. Then, Cameron gives his speech [dubbing the area Tech City], and while initially employment keeps going down, it sort of recovers by 2013. There's no way we'd argue that one caused the other, but it's quite interesting that the jobs bounce you might have been expecting didn't actually happen.



BELOW Tech clusters, such as Tech City in East London, help firms to develop ideas and create opportunities

We have a measure of some start-up survivors, those firms that are still active a year later; and these numbers show a decline too, which is surprising. But I guess you can explain it by churn: everybody hears about Tech City, a lot of people pile in, a lot of their ideas aren't particularly good, they subsequently fail.

■ You're also looking at rent increases in the area. What have you discovered?

The clear upward trend we've seen is in the cost of doing business in the area, in terms of rent. Figures show that rents are flat for a while, then start to rise around mid-2012. The cost advantage of the area has eroded quite a lot. If you talk to companies working in the area, and estate agents too, they'll confirm this.

It's consistent with what you'd expect, however. In part, down to the fact that as it becomes more popular, more people start coming in; and also because as awareness of it grows, people start talking it up. I think those two things together probably go some way to explaining those trends.

■ If you could give David Cameron advice on Tech City and other tech clusters, what would it be?

I'd just remind him of what he said in 2010, which is that the government wanted to be hands-off.

What they've actually done is some of that, and then, occasionally, been rather heavy-handed in attempting to push the cluster into the Olympic Park, or that huge building that they were trying to put on top of Old Street Roundabout. Essentially, the government needs to avoid the politically friendly policy initiatives, and instead focus on the more boring and important stuff that helps the cluster to actually grow.

■ Why do start-ups and tech firms like to cluster so much?

They're working on stuff that's at the technological frontier. Ideas and conversations and opportunities are important, and the best way to pass those around is still face to face.

One of the things that was very striking when we were talking to people is their intensive use of cloud services and tools to work remotely. However, they still felt that it was important for their work, and for their image, to be in an area that's close to one another other, and be able to reach out and talk to people. I can't really see that changing. ●



What is... HTTP/2?

Loading web pages is about to get quicker, thanks to the first upgrade to the HTTP protocol in 16 years. Here's why HTTP/2 matters



Phone manufacturers may upgrade their handsets every year, but others are more patient: the hypertext transfer protocol (HTTP) is receiving its first update since June 1999. HTTP/2 brings a host of new features, but the most significant will lead to faster page-load times for us all. Here's how it works.

What is HTTP/2? Another sequel in the spirit of *Fast & Furious 2*? In a way, yes. It's like HTTP, but better, faster – and more secure. Okay, that's not a great cinematic tagline, but this is a follow-up that's worth a look. HTTP is the protocol by which links work and data is transmitted online, making it the foundation of the web as we know it. As the working group that creates these protocols noted when referring to the last version, HTTP/1.1, "its age is starting to show." Is it any wonder? It was invented the same year *The Phantom Menace* topped the box office.

How can a web protocol that basic age? Remember web pages from 16 years ago? They were lucky to include photos, let alone the graphics-intensive, video-heavy content we take for granted today. With HTTP/1.1, each element on the page is a separate request, so feature-rich pages involve a large communications overhead.

And that's now fixed? HTTP/2 addresses this problem, building on work by Google. The web giant has invented a new way of loading such features dubbed SPDY, and that's been the basis for HTTP/2 – in fact, Google has dropped SPDY now that HTTP/2

uses so much of it. One key feature is multiplexing, which loads page elements at the same time over a single connection. The browser can request more than one element at a time, helping to speed things along.

What does that mean for me? Don't be selfish – but yes, there are benefits for users. Pages will load more quickly, and thanks to header compression and condensing transmissions to a single server connection, this should be especially noticeable on mobile devices. There are a few other benefits, notably involving security. HTTP/2 has better encryption support and works only with TLS1.2, an updated version of the transport layer security protocol. However, HTTP/2 has already been criticised for not going far enough with security, so not everyone is satisfied with the upgrade.

And is it live now? HTTP/2 has been approved, but it's still in the final editing process. It will take some time before it becomes the official standard for the web, and more time thereafter for rollout. That said, the current release of Chrome and Firefox already support HTTP/2.

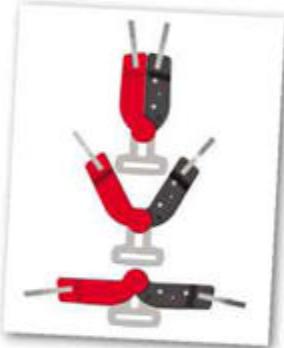
When it does arrive – and will it break anything? Cleverly, HTTP/2 is designed to be backwards compatible, so client or server devices can choose which version of the protocol to use. Plus, the developers have made great efforts to maintain a high level of compatibility with HTTP/1.1 – existing web applications should work exactly as they do today, while new ones can be developed to work faster using HTTP/2.

Crowdfund this!

Our pick of UK tech projects on Kickstarter and Indiegogo

ResisTracker

Another workout wearable? This isn't a fitness band in the usual sense. Rather, it's a device that turns regular "dumb" resistance bands and suspension trainers into smart workout devices, tracking your training data to help you set goals and keep your exercise balanced.



How does it do that? The ResisTrack is a small handheld device that uses Bluetooth and a pair of sensors to measure and record the muscle force exerted by your arms and legs through a resistance band. You don't need any additional equipment: you can simply attach an existing band, select a workout plan in the mobile app, and get moving. The device measures the force you're applying, counts your repetitions and tracks your progress, which its developer claims make it easier to stay motivated.

And it tells you when to stop? Like a digital personal trainer, it prevents injuries by analysing your performance and warning you if you're getting carried away.



If the battery dies mid-workout, can I return to the sofa? The developer is claiming a two-week battery life, and a recharging time of less than two hours, so that excuse may not hold. It's also splash-proof and shock-proof. It works with the iPhone 4s and up, iPad 3 and up, and Android or Windows 8.1 devices with Bluetooth Smart support.

How much does it cost? If you get in early, you can pick up a ResisTrack package for £66; the next tier starts at £93 and includes a ten-minute setup session via Skype. For an additional £13, you'll receive a workout poster, and if you're ordering for a gym, there's a ten-pack kit for £1,328. Delivery is promised in October, assuming the project gets funded.



At the time of writing, funding stands at a little over £1,600, against a target of £50,000, but it's early days: you have until 5 May to pledge your support.

Link: pcpro.link/248resis

Geek Day Out: The Royal Institution

The Royal Institution's Michael Faraday Museum in London offers a fascinating glimpse into how science and engineering geniuses developed their ideas



The Royal Institution (shortened to Ri by the institute in a geeky nod to Pi) has been a base of research for some of the most famous scientists and inventors in the world. Illustrious names include electron discoverer JJ Thomson and photography pioneer William Henry Fox Talbot – and you can see their genius in action at the Michael Faraday Museum in London.

Over three floors you'll find items from the first thermos flask to the miner's safety lamp, plus work from the museum's namesake: Faraday's magnetic laboratory is displayed as it was in the 1950s.

"From the odds and ends that became the first electrical transformer to the tube that told us why the sky is blue, visitors can view the actual objects Ri scientists built and used in some of the world's most famous

experiments," Charlotte New, curator of collections at the Royal Institution, told *PC Pro*.

Through a gallery of touchscreens, visitors can find out about the science behind the innovations; these show excerpts from scientific notebooks and photos of early labs. Also on show

is an interactive periodic table, where visitors can listen to Tom Lehrer singing his periodic table song

while the ten elements associated with the Ri light up.

Entry to the Royal Institution's Michael Faraday Museum is free and it's open Monday to Friday from 9am to 6pm.

The museum has been designed to appeal to

11-year-olds and above, and there's a Family Fun Day focusing on light, featuring lasers and rainbows, on 16 May. The Royal Institution also holds Ri Lates for adults only. For more information, visit pcpro.link/248ri.



ABOVE Visitors are invited to get hands-on with historical science

BETWEEN The UK's first spaceport will be used to launch satellites and operate commercial flights



Coming up British spaceport

Five locations have been picked out as potential homes of the UK's first spaceport

Five locations have made the shortlist for the UK's first spaceport, which the government hopes to have up and running by 2018.

Under consideration are Campbeltown, Glasgow, Prestwick and Stornoway in Scotland; Newquay in England; and Llanbedr in Wales.

One key characteristic of all five locations is that they're situated on the coast, enabling take-off and landings over the water, to help cut risk. Other requirements include being away from areas of high population and having room for a 3km runway.

The spaceport will become the home of commercial spaceflight in Britain, and will be used to launch satellites and for tourist space flights.

"Launching satellites and operating commercial space flights from our shores was once confined to the depths of science fiction, but with the results of this consultation we're one step closer to making this a very real ability in the near future," said business minister Vince Cable.

The spaceport plans come as private companies such as Virgin Galactic and Elon Musk's SpaceX are working to perfect the technology for commercial flights. Both have suffered major setbacks: Virgin had hoped to begin flights this year, but its rocket crashed in the US last year, while the SpaceX Falcon 9 crashed into a platform in the sea in January.

Coding challenge

Using recursion to solve the puzzle of the wine merchant



» Real-world problem

Recursion is an important programming principle, which can be illustrated with a real-world problem – dividing a pizza so that a certain number of friends each get at least one slice. A simple recursive solution is to start by cutting the entire pizza in two, and then – if you don't yet have enough slices – halving the resulting pieces again and again until you do. Here's how we might express that in pseudocode:

```
def slice_pizza(current_slices, desired_slices)
    if current_slices < desired slices
        current_slices = current_slices * 2
        call slice_pizza(current_slices, desired_slices)
    else
        return current_slices
    end function
```

The recursive part is the way in which the number of slices is repeatedly fed back through the doubling function, until the “escape condition” is met – that is, until we have enough slices. (If you're worried about wastage, you can run the function again on any leftover slices, or just eat them yourself.)

This month's challenge is similarly recursive. It concerns a wine merchant, who once ordered a large consignment of wine from the most prestigious vineyard. Since the merchant had an obsessive personality, he decided that he'd only sell this wine in batches of exactly 25% of the bottles he held in store.

Happily, the wine was so good that on the first day he managed to take an order for exactly 25% of his stock. To celebrate, he opened a bottle and quaffed it himself. On the second day, he again sold exactly 25% of his remaining stock, and celebrated by drinking another bottle. This pattern continued for the rest of the week; but at the start of the seventh day, the number of bottles remaining wasn't divisible by four – so rather than break his rule, the merchant stopped trading (and drinking).

How many bottles had the merchant ordered to start with? To find out, we might write a recursive function that takes an initial value, reduces it by a quarter, subtracts 1 from it, then feeds the

result back into itself six times over, to represent six days of sales. At the end, we can test whether the final result is a whole number that isn't divisible by four. If it is, we have our solution; otherwise, we can increment the initial value by one and repeat the process.

» Escape conditions

Most starting values will lead to a number of bottles that isn't divisible by four in the first day or two, so iterating through the full six days is a waste of time and computing power. We can work more efficiently if we recall escape conditions: instead of going through the function a fixed number of times, let's create a function that exits as soon as it reaches a number of bottles that isn't divisible by four:

```
def sales(day_number, bottles_left)
    while bottles_left > 0
        if bottles_left / 4 = int(bottles_left / 4)
            bottles_left = bottles_left * 0.75
            bottles_left = bottles_left - 1
            day_number = day_number + 1
            call sales(day_number, bottles_left)
        else
            return day_number
        end function
```

Now we can feed this function a series of starting values, and see which causes it to return the value 7. Of course, there are multiple solutions, but if we count upwards (perhaps using a for... next loop) we can find the one that requires the fewest bottles.

A further possible optimisation might be to check whether the day count has passed 7, and

immediately move on to the next initial value if it has – since we know this one didn't cause the merchant to stop selling on day 7, as the problem required. In this case, though, that will happen rarely, so checking it at every pass through our

function might waste more time than carrying out the odd calculation that goes past day 7.

Try to implement the full program in the language of your choice. Then, try solving the problem in reverse: modify the function so that it takes a final number of bottles as input, and uses a recursive function to work out whether this number could have been reached after six days – or whether such an outcome would have required the merchant to start trading in fractions of bottles. **DAVID HUNT**

“At the start of the seventh day, the number of bottles remaining wasn't divisible by four”



How can anyone justify spending so much extra on a gold Apple Watch? asks Jon Honeyball

What is something worth? It's a tricky question to answer, because questions about value for money are rarely straightforward. If the device is a functional item, then you can ask whether spending more money will allow it to do its intended task better. Will it do it more reliably? Will it last longer, and require less maintenance?

Then there are the more nebulous things. Do I like it, and like it enough to spend the money? Do I feel good; better than I would with a cheaper item? Do my friends prefer it, and do I like the image it projects to people?

Answering those questions is difficult, either for something generic or more specific. For example, a rare painting might sell for £30 million. Does that make it "worth" £30 million, in the same way that the money would pay for a few dozen luxury apartments in central London? You might view it as an investment, in which case part of your reasoning boils down to this: could parking your 30 Big today result in it rising to 40 Big in a couple of years? In this regard, it doesn't matter if it's a Monet or a tin of baked beans, it's entirely a financial transaction.

My questioning has come about because recently I've been looking and thinking about the value of things, specifically brought on by the pricing of the Apple Watch "Edition". It had been anticipated before launch that the price would run into thousands of pounds, but even so, the revelation that the most luxurious model will retail at £13,500 including the strap has resulted in a few double takes.

Now, there's nothing unusual about high-end watches with high prices. Look at the price lists for vendors such as Patek Philippe, or Jaeger-LeCoultre, and you'll soon see that they use the extra-wide calculator with the additional digits in the display. Whether a Patek is worth £50,000 or £100,000 or more comes down to this difficult decision about cost and value. Clearly these devices are hand-made, are magnificent items of engineering, and in some cases may well be good financial investments. So why are people so squeamish about Apple setting a luxury price for the gold version of the Watch?

Part of it comes down to knowing that its functionality will be determined by battery size,

processor function and screen capability. This won't exactly degrade over time – although the battery life will inevitably drop off from the already-short 18 hours that Apple has promised – but nevertheless, we're wary of spending this sort of money on this kind of device. We're all used to buying phones and gadgets that become valueless within two years, either due to hardware failure or newer, disruptive technology that's currently just over the horizon.

Apple can potentially fight the obsolescence argument if it offers an ongoing upgrade/service process, allowing customers to replace the innards of more expensive models as new versions come along. If the company has been sensible, then it's quite likely that it's designed the frame with this in mind, so customers can keep wearing their glamorous fashion accessories for years, or even decades, without falling behind on the internal technology.

And this doesn't have to be cheap. Those who already buy expensive watches know that servicing can be horrendously

expensive, even as a proportion of the retail price. I recently had Breitling service my Emergency watch, and the bill wasn't far off £1,000. Servicing a Patek or Jaeger can be positively wallet-emptying. So I don't have a real issue with the ongoing maintenance cost – I'd rather pay and keep something working than discard and buy new.

But there's still a reason I won't be buying the gold Apple Watch Edition. Visit the Save

The Children website and you'll see that, according to its claims, "£3 could pay for life-saving treatment for eight children with diarrhoea". With the most extravagant Apple Watch costing 45 times as much as the functionally identical basic model, the difference can't be justified in terms of capability, just as the price of a Patek can't be justified for its accuracy of time-keeping.

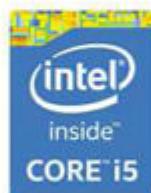
Apple can claim the extra is justified for its engineering purity, design and expression of workmanship as an artform. But the £13,200 premium for the top-end Apple Watch, versus one made from a lesser metal could pay for treatment for more than 4,000 children. Enjoy your Patek, your Breitling, your Jaeger for the incredible micro-engineering they embody: the precision, workmanship and skill involved. But if I see a gold Apple Watch, I will only be able to think of the children with life-threatening illnesses going untreated.

■ Jon Honeyball is a contributing editor. Never mind Apple products, he's hoping fusion power will change the world for the better. Email jon@jonhoneyball.com



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